FINAL REPORT

Reclamation of Wood Materials Coated with Lead-Based Paint

ESTCP Project SI-0309

March 2009

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14. ABSTRACT

In this ESTCP demonstration, three wood buildings were deconstructed at Camp Roberts, CA, to salvage and reclaim valuable wood coated with lead-based paint (LBP). Because the presence of LBP normally prohibits the recycling of older wood construction materials, economic value is lost, landfilling costs compound, and virgin materials are consumed unnecessarily.

Wood Waste Diversion (WWD) of Pacific Grove, CA, demonstrated a technology that mechanically removes coatings from wood, producing clean wood feedstock while effectively sequestering lead-contaminated particulates and residues for proper disposal. The WWD mobile planing unit removed LBP coatings from redwood and Douglas fir siding materials, making them suitable for sale and reprocessing into flooring, paneling, and architectural millwork. Much of the redwood material produced in this demonstration was used in new, sustainably designed modular homes fabricated in southern California.

The WWD technology performed well and economically. However, a project-unique extra cost was incurred because of a claim related to a contractor's operational decision that does not represent a fundamental technology performance issue. Also, the contractor's deconstruction process required more labor than expected, raising the total project cost. Finally, the scale of the project did not produce enough materials to attract high market interest, resulting in lower-than-expected selling prices.

15. SUBJECT TERMS
construction and demolition waste; Camp Roberts, CA; deconstruction; hazardous waste; lead-based paint removal; recycling; Resource Conservation and Recovery Act (RCRA); sustainable infrastructure

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- California Army National Guard, Camp Roberts, CA
- U.S. Army Corps of Engineers, Mobile District
- U.S. Department of Agriculture, Forest Products Laboratory
- Department of Environmental Engineering Sciences, University of Florida
- Wood Waste Diversion
- Ahtna Government Services Corporation
- U.S. Naval Facilities Engineering Service Center
- U.S. Air Force Center for Environmental Excellence

Details are provided under Points of Contact, Chapter 8.

List of Acronyms

ACM	asbestos containing material
ACSIM	Assistant Chief of Staff for Installation Management (Army)
AERTA	Army Environmental Requirement and Technology Assessments
AFRP	The Army Facility Reduction Program
AGSC	Ahtna Government Services Corporation
bf	board foot (wood volume equivalent to 12 x 12 x 1 in.)
C&D	construction and demolition (waste debris)
CA	California
Cal WET	California Waste Extraction Test (as defined in CCR Title 22)
CCR	California Code of Regulations
CEQA	California Environmental Quality Act (1970)
CERL	Construction Engineering Research Laboratory (i.e., ERDC-CERL)
CESAM	Mobile District, South Atlantic Division, U.S. Army Corps of Engineers
CFR	Code of Federal Regulations
CIWMB	California Integrated Waste Management Board
COE	Corps of Engineers (United States Army)
COR	Contracting Officer's Representative
COTR	Contracting Officer's Technical Representative
CPSC	Consumer Products Safety Commission
CQC	contractor quality control
CSUMB	California State University at Monterey Bay
CTC	Concurrent Technologies Corporation
cy	cubic yard
dem/val	Demonstration/Evaluation (ESTCP)
DMRO	Defense Marketing Reutilization Office
DoD	U.S. Department of Defense
DOT	U.S. Department of Transportation
DPW	Directorate Public Works
DTSC	Department of Toxic Substances Control (California)

EPA	U.S. Environmental Protection Agency
ERDC	U.S. Army Engineer Research and Development Center
ESTCP	Environmental Security Technology Certification Program
FORA	Fort Ord Redevelopment Authority
FPL	Forest Products Laboratory (U.S. Department of Agriculture, Madison, WI)
FRP	Facility Reduction Plan
ft	feet
HASP	Health and Safety Plan
HEPA	High Efficiency Particulate Air (filter)
HMBP	Hazardous Materials Business Plan
hr	hour
HSS	high-speed steel (cutting edge)
LBP	lead-based paint
lf	linear feet
LLC	Limited Liability Company
MBUAPCD	Monterey Bay Unified Air Pollution Control District
MoM	Measure of Merit (DoD)
MSDS	Material Safety Data Sheet
MSW	municipal solid waste
MU	mobile unit (WWD)
NAL	National Analytical Laboratories, Inc.
NESHAP	National Emission Standard for Hazardous Air Pollutants
NIOSH	National Institute for Industrial and Occupational Health
OSHA	Occupational Safety and Health Administration
P2	Pollution Prevention
Pb	lead
PEL	Permissible Exposure Limit
PP	pollution prevention
PPE	personal protection equipment
ppm	parts per million (in this report, equivalent to 1 milligram per kilogram)

PWTB	Public Works Technical Bulletin
QA/QC	Quality Assurance / Quality Control
R&D	research and development
RCI	Residential Communities Initiative
RCRA	Resource Conservation and Recovery Act
SERDP	Strategic Environmental Research and Development Program
SETAC	Society of Environmental Toxicology And Chemicals
sf	square feet
SPIB	Southern Pine Inspection Bureau
T&G	tongue and groove
TC	toxicity characteristic
TCLP	Toxicity Characteristic Leaching Procedure
UFCCE	University of Florida Center for Construction and Environment
UFGS	Unified Facilities Guide Specification
U.S.	United States
USACE	United States Army Corps of Engineers
WARM	Waste Reduction Model (EPA tool to analyze greenhouse gas emissions)
WCLIB	West Coast Lumber Inspection Bureau
WWD	Wood Waste Diversion, LLC, Pacific Grove, CA
WWII	World War II

1. Introduction

1.1 Background

Waste disposal is a "Number One" Pollution Prevention and Compliance priority for the U.S. Army and the other military services. Some installations have reported that up to 80% of their solid waste stream can be composed of construction and demolition (C&D) debris.

Tens of thousands of temporary wooden buildings from the World War II (WWII) era, comprising over 50 million square feet (sf) of floor area, await removal from numerous U.S. military installations. The Principal Deputy Assistant of the Army (PDASA) has committed the Army to supporting initiatives whereby the Army and surrounding communities can benefit from the reuse of excess Army buildings. The U.S. Environmental Protection Agency (EPA) Office of Solid Waste has sponsored research at ERDC/CERL to identify the potential for C&D debris diversion from landfills. Wood coated with lead-based paint[1] (LBP) makes the removal and disposal of debris from these buildings problematic in terms of both process and cost.

"Smash-n-trash" landfilling is the most common disposal method for building debris, and the reuse or recovery of the LBP-coated wood has seldom been attempted. In some states, such as California, where 40,000-plus wooden buildings must be removed from military sites, LBP-coated wood is often regulated for disposal only in a hazardous waste landfill, which is expensive both in terms of money and the reduction of landfill service life. The issue of landfill life is of great concern: there are now few operating landfills on Army installations, and the number of commercial landfills has decreased from about 10,000 to approximately 2,000 sites over the past 10 years. Removal of the LBP from wood waste could reduce the volumetric burden on landfills by 60 – 75%.

It is notable that apart from its deserved reputation as an environmental and health hazard, LBP provided excellent protection from the elements to the wood that it covered. Proprietary milling machines and processes can be used to economically reclaim the lead- contaminated wood, providing a means to recover a valuable resource which would otherwise be sent to landfills. The wood specimen shown in Figure 1.1 is Douglas fir of "C" (or custom) grade, which signafies the highest quality; it is expected that most of the recoverable wood in California and the northwest United States will be of the same or similar high-quality grade. The recovered wood could be reused as a construction material or reprocessed with value added to make high-end, revenue-generating wood products such as flooring, siding, trim, paneling, etc. (Figure 1.2). It is estimated that 60 – 75% of the wood from WWII-era barracks can be recovered. Doing so could

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[1] Lead-based-paints were produced in the United States as early as 1804. Lead pigments were used extensively in exterior and interior oil paints up to the mid-1970s.

lead to significant cost savings in the building removal process and a dramatic decrease in the volume of wood waste trucked to landfills.

Figure 1.1. A piece of premium grade Douglas fir recovered from Fort Ord[2].

Figure 1.2. T&G paneling with finger grooved pieces remanufactured from LPB-coated siding.

[2] Original Grade Stamp, West Coast Lumber Association, Visual Grade C for "Custom", Mill 83.

1.2 Objectives of the Demonstration

This project demonstrated a process to economically recover materials from obsolete buildings and capitalize on their value instead of disposing of them in a landfill. The purpose was to validate, on a production scale, the use of innovative woodworking equipment to reclaim architectural wooden members such as exterior siding and dimensional lumber that have been coated with LBP. In addition to laying the groundwork for large-scale processing and remanufacturing operations, the demonstration included an exploration of large-scale marketing of the recovered wood products. The work included quantitative projections of the reduction of landfill burdens, the increase in landfill service life, and a valid estimate of the return-on-investment through the recovery and sale of high-quality value-added finished wood products.

This work was performed at Camp Roberts, a large California Army National Guard installation in west-central California where more than 600 WWII-era wooden buildings need to be removed. Camp Roberts has experienced problems with the disposal of lead-contaminated wood during previous building removal activities. The planned construction of new facilities requires timely removal of targeted wooden buildings. Those buildings (see Figure 1.3) are typical of the tens of thousands of WWII-era wooden buildings still to be removed on military installations across the nation.

Figure 1.3. Vacant deteriorated WWII-era barracks coated with LBP.

With more than 50 million sf of buildings to be removed from the Army real property inventory alone, any process demonstrated to decrease removal costs would provide a significant benefit. The cost to landfill just the siding from the current list of excess Army buildings would exceed $6 million dollars. And with tipping fees for hazardous waste landfills being at least six times greater than for conventional landfills, the disposal cost would increase dramatically for any portion of siding contaminated with actionable amounts of lead. If the waste volume going to land-

fill were reduced by half of the original amount represented by whole boards, then the disposal costs would also be similarly reduced. The expected recovery rate is 60%, but given more favorable conditions, it is not unreasonable to expect to recover as much as 75% of the wood. If the revenue from the sale of the reclaimed wood or finished products were factored in, total building removal costs could be further reduced.

Also, in the case considered here, the projected benefits extend beyond direct cost savings to include pollution prevention and compliance returns on investment. Recovery and reuse of high-quality architectural wood conserves much of the energy investment embodied in the production of the original construction material while taking volumetric pressure off landfills.

The demonstration was conducted in an attempt to determine those cost savings with a high degree of confidence. Upon validation, the processes and technology could readily be transferred beyond the military services to other federal agencies, state environmental and waste management authorities, and land reuse authorities that face similar building removal and disposal problems.

Other indirect but tangible benefits associated with this demonstration include a reduced burden on forest resources, the creation of new jobs, and new sources of revenue for property owners.

Chronologically listed below are the principal goals and guidance that influenced the objectives of this ESTCP demonstration/evaluation:

- 13 May 1998, *The DoD Pollution Prevention Measure of Merit Memorandum*
  - https://www.denix.osd.mil/denix/Public/ES-Programs/Pollution/Moms/p2mom.html
  - "By the end of FY2005, ensure the diversion rate for nonhazardous solid waste is greater than 40%, while ensuring integrated nonhazardous solid waste management programs provide an economic benefit when compared with disposal using landfilling and incineration alone."

- 14 September 1998, Executive Order 13101, *Greening the Government Through Waste; Prevention, Recycling and Federal Acquisition*
  - http://www.ofee.gov/eo/13101.htm
  - "Section 101. Consistent with the demands of efficiency and cost effectiveness, the head of each executive agency shall incorporate waste prevention and recycling in the agency's daily operations and work to increase and expand markets for recovered materials through greater Federal Government preference and demand for such products. It is the national policy to prefer pollution prevention, whenever feasible. Pollution that cannot be prevented should be recycled; pollution that cannot be prevented or recycled should be treated in an environmentally safe manner. Disposal should be employed only as a last resort."

- 2000, *Recommendation of Army Pollution Prevention Technology Team* (periodically reviewed):
  - Performance Metric: divert C&D debris by 65% by FY08

- 2001, *Army Environmental Requirement and Technology Assessments (AERTA) (3.5.c), "Solid Waste Diversion"*:
  - Addresses the issues of the high volume of demolition debris going to landfills. The Training and Forces Commands of the Army also lists this as their #1 pollution prevention requirement.

- 20 November 2002, *The Army Assistant Chief of Staff for Installation Management (ACSIM) Memorandum*
  - Directs installations, where feasible and cost effective, to end the use of on-post federal government-owned solid waste landfills
  - Encourages installations to obtain solid waste collection services from local, municipal, or public/private regional authorities

- 06 February 2006 (Revised 11 July, 2006, The Army Assistant Chief of Staff for Installation Management (ACSIM) Policy Sustainable Management of Waste in Military Construction, Renovation, and Demolition Activities
  - Requires a minimum of 50% of all nonhazardous waste from Army construction, renovation, and demolition activities be diverted from landfill disposal.

- 24 January 2006, *Federal Leadership in High Performance and Sustainable Buildings Memorandum of Understanding (MOU)*
  - Includes a requirement for 50% C&D waste diversion.

- 6 March 2006, Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings
  - Provides guidance, supporting documentation and resources for implementing the Federal Leadership High Performance and Sustainable Buildings MOU.

- 24 January 2007, Executive Order 13423 Strengthening Federal Environmental, Energy, and Transportation Management
  - Consolidates several previous Executive Orders addressing recycling, waste reduction, environmentally preferable products, and sustainable buildings in the Federal government.
  - Codifies the Federal Leadership High Performance and Sustainable Buildings MOU and Guiding Principles into and Executive Order, which includes the requirement for 50% C&D waste diversion.

1.3 Regulatory Drivers

A number of regulations address the handling, transportation, and disposal of hazardous materials. The material of interest in this demonstration was lead-containing waste produced by the milling process that removed the LBP. The principal regulatory drivers are cited below, each including significant measures and milestones pertaining to LBP. The *pollution prevention* requirement relates to the recovery of materials otherwise destined for the landfill. The *compliance* requirement relates to the observance of all federal, state, and local regulations controlling the disposal of lead-contaminated materials.

1.3.1 The Resource Conservation and Recovery Act (RCRA)

RCRA waste tipping fees can vary, at the discretion of landfill owners, from $120 – $250/cubic yard (cy). Non-RCRA waste disposal rates are much lower (e.g. $30 – $65/ton). There can be considerable confusion about tipping fees based on volume versus fees based on weight. For reference purposes, from a real-world example, consider that a well packed 20 cy roll-off container full of LBP-coated siding may weigh slightly less than 2 tons, incurring a weight-based tipping fee of $60 – $130. However, volume-based tipping fees for disposal at a RCRA landfill would be at least $2,400 (i.e., 20 cy times $120). Therefore, a technology that can reduce RCRA waste volumes would lower waste disposal costs significantly.

RCRA is the primary regulatory driver for hazardous waste management activities. Passed in 1976 and amended twice in the early 1980s. Congress established the following goals for RCRA:

- To protect human health and the environment from the potential dangers of waste disposal
- To conserve energy and natural resources through waste recycling and recovery
- To reduce the amount of waste generated
- To ensure that wastes are managed in an environmentally sound manner.

Some of the features of RCRA that affected this demonstration were:

- Presence of LBP classifies the wood as a RCRA hazardous waste that must be disposed of in a hazardous waste landfill.
- Lead-containing waste is defined as hazardous when it leaches 5 ppm[3] of lead or greater in the Toxicity Characteristic Leaching Procedure (TCLP) analysis.
  - o The TCLP extraction is designed to simulate the climatic leaching action expected to occur in landfills.
  - o When this extraction method is used, solid matrices are reported in liquid units.

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[3] ppm: parts per million; 100 ppm = 0.01% by weight. This is equivalent to 1 mg/kg.

- Some states exempt LBP-coated residential structure demolition debris from the requirement to dispose in hazardous waste landfills. Even where exempt, however, the buildings are often left standing because of concerns about long-term liability.

1.3.2 The Occupational Safety and Health Administration (OSHA)

This project is affected by OSHA rules that prevent lead-containing waste from being released into an environment where workers are present:

- OSHA mandates include the regulatory requirements for *Hazard Communication Standards and the Hazardous Waste Operations and Emergency Response Worker Protection Standard*.
- OSHA *Lead in Construction Rule* (29 CFR Part 1926.62,June 1993):
  - applies to construction (deconstruction) work where any lead containing material is present.
  - applies to all construction work where an employee may be exposed to lead: demolition or salvage, new construction, alteration, repair, transportation, disposal, storage or containment of lead or materials containing lead on the construction site
  - action level is 30 $\mu g/m^3$ over an 8-hour period
  - permissible exposure limit (PEL): 50 $\mu g/m^3$ for an 8-hour period
  - methods of compliance involve
    - engineering and work practice controls: to keep exposure below the PEL
    - ventilation of enclosed areas where required: to supplement work practice controls
    - administrative controls: job rotations to shorten shifts in exposure area
  - construction activity allowable exposure levels ($\mu g / m^3$)
    - blasting in containment 27,000
    - cutting and burning 600
    - hand scraping 96
    - manual demolition 50
    - chemical stripping 11

Other regulations protecting the public and the health of employees in the workplace from hazards related to the management and transportation of hazardous waste are enforced by the U.S. Department of Transportation.

1.3.3 The Department of Transportation (DOT)

The DOT regulates the transportation of hazardous waste. All local city, county, state, Federal and U.S. Army regulations are observed. The primary concern will be the safe handling, processing, containment and disposal of the LBP-contaminated shavings and scrap.

1.3.4 Lead-Based Paint Poisoning Prevention Act, 1971

- Prohibited the use of LBP in Government housing or federally-assisted housing.

- Was defined as > 1% lead by weight.

1.3.5 Consumer Products Safety Commission (CPSC), 1977

- Regulated use of paints for residences, public area, paints on consumer products, and general sales to the public
- Limited lead level to 0.06% by weight (600 ppm).
- 16 CFR Part 1500.230 "Guidance for Lead (Pb) in Consumer Products", 1998
    - "…any firm that purchases a product for resale is responsible for determining whether that product contains lead and, if so, whether it is a 'hazardous substance.' "
    - http://www.cpsc.gov/businfo/frnotices/fr99/lead.html

1.3.6 Department of Housing and Urban Development

- Incorporates CPSC lead standard of 600 ppm by weight in dry paint
- Limits lead content in measured surface to 1 mg/cm^2 using nondestructive X-ray fluorescence analyzer
- Applies to child-occupied Federal housing and other child-occupied facilities.

1.3.7 California State and County Agencies

There are numerous California State and County agencies and legislative actions who also have oversight concerning the handling of hazardous materials. Their requirements generally mimic Federal laws. For the purposes of this Demonstration Plan their existence is simply noted here:

- California Environmental Quality Act (CEQA), 1970
- California Integrated Waste Management Board (CIWMB)
- California Department of Toxic Substances Control (DTSC))
- Monterey County Department of Health (MCDH)
- Monterey Bay Unified Air Pollution Control District (MBUAPCD)

1.3.8 Unregulated Residual Lead Levels in Reprocessed Wood

Currently there are no regulations that specifically constrain residual lead levels in wood from which LBP has been removed. Because the purpose behind most lead regulation is to protect children from consuming LBP, it is reasonable to assume that such a regulation would follow the guidelines of the CPSC in restricting lead levels in paint to 0.06% by weight, or 600 ppm. Part of this demonstration includes a dialog with the EPA and the CSPC to establish appropriate safety levels for the recovered wood.

When establishing a limit for lead in consumer paints, CPSC relied on medical research that indicated a very young child could ingest 15 µg of lead daily without ill effects. That finding was the basis upon which CPSC established 0.06% as the maximum quantity of lead allowable in

consumer paints. Note that the 15 µg value is not a regulatory limit or threshold in and of itself. In order for a child to ingest 15 µg of lead from the wood typically coming from these operations, he or she would have to consume 0.5 – 1 cu cm of wood daily, at a 0.06% lead concentration, which is an improbable amount. For a more thorough discussion of the safe handling of the final wood products, see Appendix E.

1.4 Stakeholder and End-User Issues

The results of this demonstration enable both the public and private sectors to evaluate the technology in comparison with their own scales and capabilities. The Army installation Directorate of Public Works (DPW) must consider the cost of the technology and its effectiveness in reducing the volume of wastes needing to be trucked to hazardous waste landfills. Responsible personnel will have to decide whether enough lead-contaminated materials will be generated to warrant the acquisition of a suitable planing machine, or whether contracting for the services will suffice. Installation management will also need reliable projections of disposal cost avoidance and a realistic assessment of whether any significant amount of revenue will accrue from the marketing of value-added products made from the recovered wood.

2. Technology Description

2.1 Technology Development and Application

A straightforward way to divert and reclaim the large amounts of LBP-coated wood currently going into landfill is to mechanically plane the paint film from the board surface. With the LPB removed, the board can then be further machined into value-added profiles for use as flooring, siding, or wainscoting. The shavings from the planing process, which may include a surface layer of lead-contaminated wood, represent a small fraction of the volume of the original board.

The advantage of mechanical paint removal versus chemical or thermal stripping is that it leaves no hazardous chemical sludge to dispose of: the waste product is dry and concentrated, ready for appropriate disposal or further processing to reclaim the lead. The shavings can be treated with portland cement or a phosphate to stabilize the lead compounds, and landfilled. In California and other states, lead treated in this manner costs less than by other methods to landfill.

Figure 2.2 illustrates the differences between conventional smash-n-trash building demolition and disposal methods and the proposed alternative process for reclaiming LBP-contaminated wood.

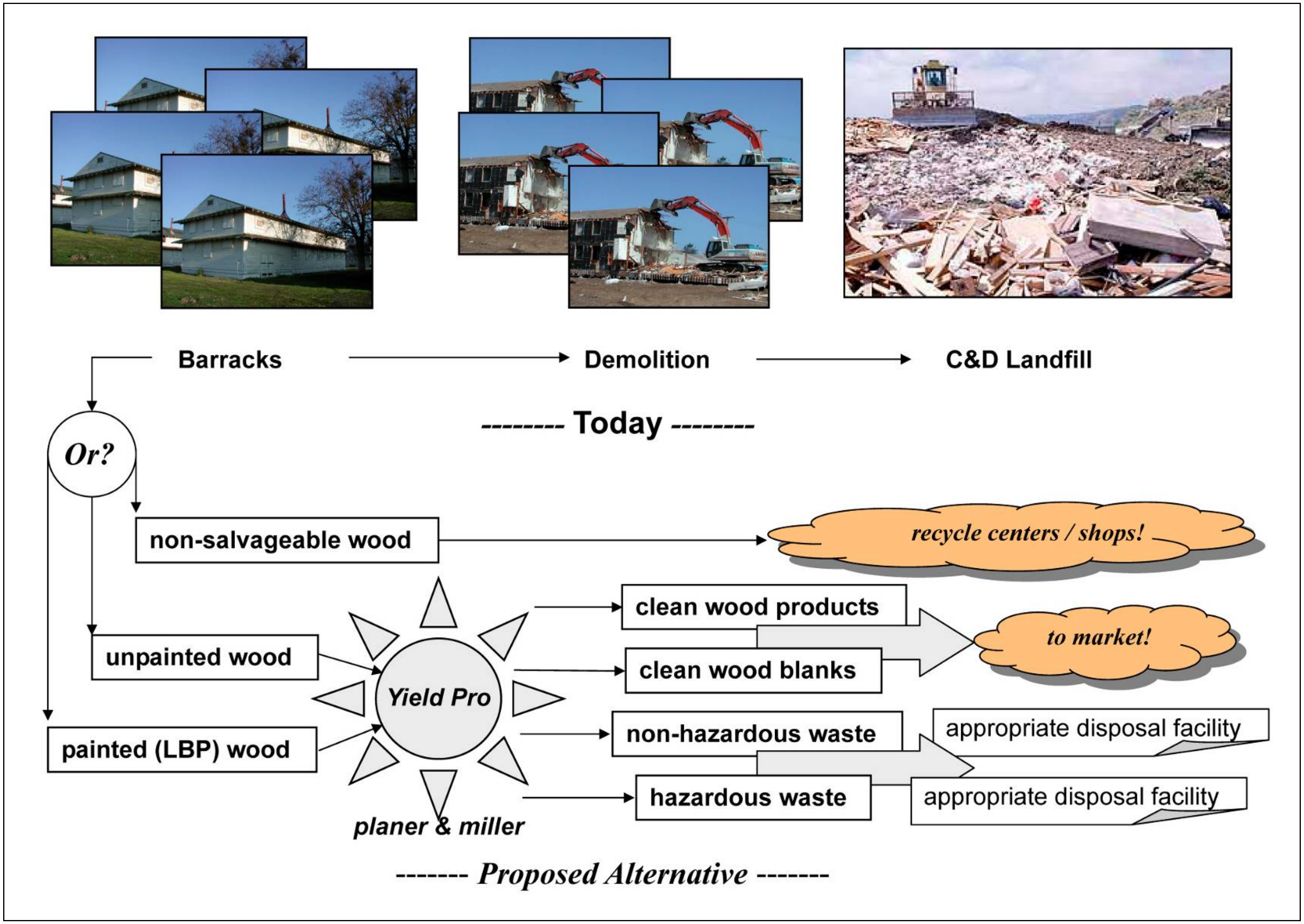

Figure 2.1. Alternative to landfilling C&D debris from WWII Barracks coated with LBP.

Under current regulations, an allowable level of lead for trace amounts in the recovered wood has not been formally established. Permissibility can be ambiguous and the "permissible" amount still needs to be formally defined. During the laboratory-testing phase of this technology, some recovered samples had trace amounts of lead below the painted surface but the concentration gradient tapered off quickly[4]. As indicated in Table 2.1, total lead concentrations for six samples of siding from the former Fort Ord indicate that surface concentrations average about 5,500 ppm and drop to an average of about 27 ppm at an average depth of about 0.06 in[5]. These results indicate that the lead contained in LBP does not penetrate the wood siding in significant quantities more than a few hundredths of an inch.

Table 2.1. Penetration of lead in wood siding from Fort Ord.

Source Sample	**Source Sample**	**Depth of Cut**[2] (in.)	**Total Lead Before Planing**[1] (ppm)	**Total Lead After Planing** (ppm)
Fort Ord	a	0.04	5300	8.4
	b	0.05	6500	6.9
	c	0.05	7500	65.0
	d	0.07	1700	48.0
	e	0.08	6500	2.4
	f	0.10	5400	26.0

[1]*Indicates a sample with no planing (i.e., all paint remaining).*

[2]*Amount of material removed with planer from top surface (painted) of siding.*

Although the proposed paint removal process is simple in concept, there are difficulties to plan for in practice. Milling old and warped wood can be difficult. Aged wood can become very hard, and sometimes contains embedded nails. Visible nails must be removed before milling. Embedded nails can instantly ruin a standard industrial planing blade. However, hidden nails are less of a problem for an innovative woodworking machine made by Auburn Machinery[6], Inc.(AMI), Lewiston, ME. The AMI Yield Pro line of woodworking equipment uses a patented machining head that resists damage from hidden nails, but is still able to resize and produce a smooth finish on the board.

The lumber recoverable from WWII-era barracks can be used to create standardized woodworking profiles. This is important because it facilitates entry into the mass market instead of only niche markets for low-volume or highly specialized wood products. Once the LBP is planed from

[4] Falk et al. 2005.

[5] Falk et al. 2006.

[6] A subsidiary of Auburn Enterprises, Auburn, ME.

the wood, each piece of wood must be assessed to determine the most suitable profile, such as flooring, paneling, or trim. Several examples are shown in Figure 2.2, Figure 2.3, and Figure 2.4. Each specimen's attributes, such as wood species, physical quality, dimensions, local market resale value, or other factors, will determine the most appropriate profile to be milled.

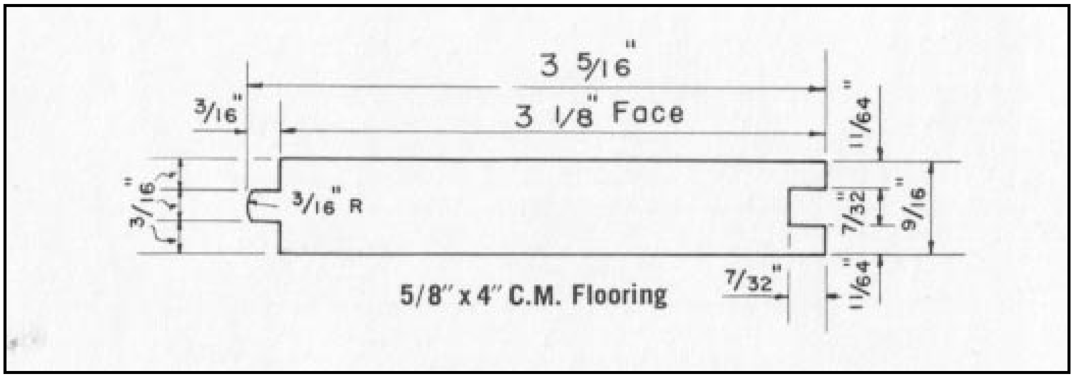

Figure 2.2. Section of typical T&G flooring profile

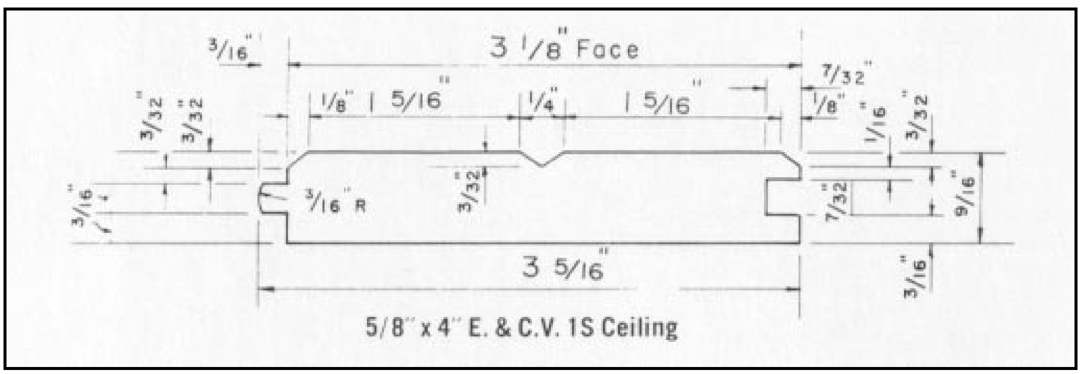

Figure 2.3. Section of typical V-groove paneling profile

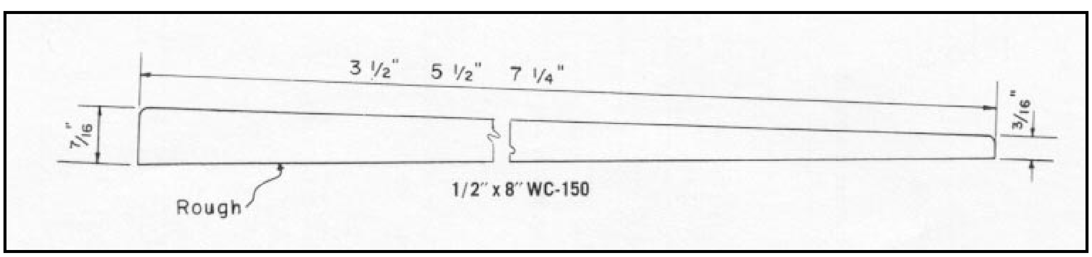

Figure 2.4. Section of typical bevel siding profile.

For this ESTCP demonstration, the paint was removed by milling the wood into *blanks*. The intention was for Wood Waste Diversion, LLC (WWD), Pacific Grove, CA (a project subcontractor/partner) or a purchaser of the blanks to subsequently mill the blanks into market-ready profiles based on an analysis of market demand, available distribution channels, and other considerations. Figure 2.5, Figure 2.6, and Figure 2.7 show examples of finished products of the demonstration.

Figure 2.5. T&G flooring remanufactured from WWII-era barracks.

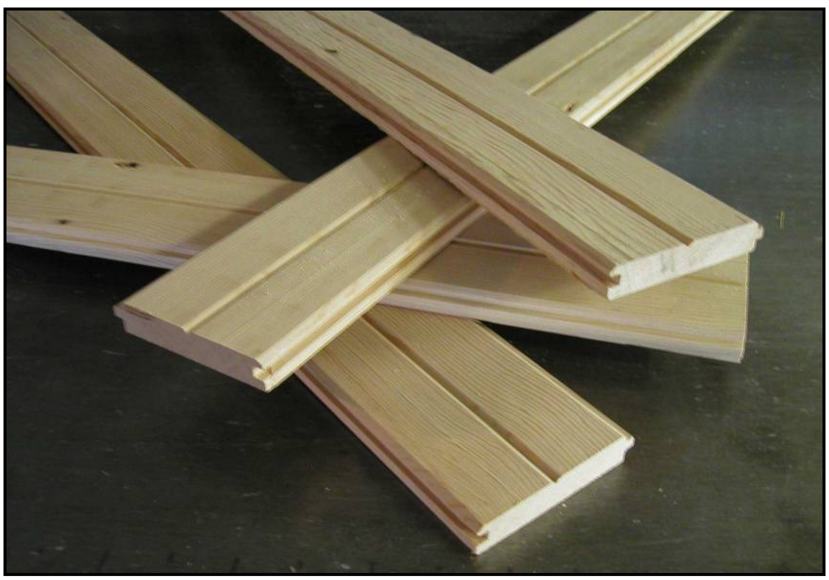

Figure 2.6. V-groove paneling remanufactured from WWII-era barrack.

Figure 2.7. A box for packaging fine wines, made of wood recovered from Fort Ord.

2.1.1 Stage/Unit Descriptions

The appropriate handling of LBP has a history dating back to the 1970s. Such technologies include concrete encapsulation, post-removal phosphate treatment to make the lead inert, chemicals applied in situ to make the lead inert, and thermal spray vitrification to remove and encapsulate the LBP. Those methods are designed to prevent lead from leaching into groundwater after it has been deposited in a landfill. A practical, self contained system specifically designed to safely and economically remove LBP from wood — the mobile unit demonstrated in this project — was conceived in 2000, and demonstrated on a laboratory scale through leveraging with deconstruction demonstrations at Fort Campbell, KY, and the former Fort Ord, CA. The individual components of this demonstration are described in section 3.6.

2.1.1.1 WWD Mobile Unit

All painted wood was processed using a mobile planing unit designed and assembled by WWD. The central feature of the mobile unit (MU) is the YieldPro wood planing and sawing machine (Figure 2.8), which can process up to 3 surfaces of wooden stock using any of several different configurations.

The configuration evaluated in this demonstration consisted of three planing heads (top, bottom, and one side head) and a side-ripping blade. (Hogging blades can also be used for greater material removal.) The MU is capable of machining three surfaces simultaneously in a variety of configurations.

The YieldPro was housed in a self-contained mobile trailer that includes standard commercial electrical generation, air compression, dust collection, residue storage, and fire-suppression systems (Figure 2.9 and Figure 2.10).

The dust collection system is equipped with a HEPA filter to contain shavings, sawdust, and debris. The residue storage chamber is equipped with an auger conveyer for transferring the collected debris into transport containers.

Figure 2.8. Auburn YieldPro wood milling machine.

Figure 2.9. Mobile unit during setup.

Figure 2.10. Mobile unit with recovered Douglas fir lumber.

During the demonstration, efficiency enhancements were suggested and tested in order to further improve the economics of the process. Experienced equipment operators were employed to avoid upwardly skewing process costs with a learning curve that would not actually be a recurring factor in an established operation. However, the cost did include equipment use and maintenance costs in addition to the deconstruction procedures and waste disposal costs.

The MU was designed for purposes that align perfectly with the demonstration objectives stated in Section 3.1.

2.2 Previous Testing of the Technology

The U.S. Army Corps of Engineers (USACE) Engineer Research and Development Center's (ERDC) Construction Engineering Research Laboratory (CERL), in a cooperative effort with the USDA Forest Products Laboratory, previously completed a small-scale project using the subject wood reclamation technology. In that demonstration, the siding from two WWII-era barracks was removed and processed through the Yield Pro planer. Various ways to reuse and recycle the demolition debris from Fort Campbell and Fort Ord WWII-era wooden buildings were investigated during summer 2002. Optimal profiles for the recovered siding were considered (see Section 3.5).

More recently, the MU was also used to remove LBP from removed from WWII-era Army buildings at California State University at Monterey Bay, CA (part of which is located on the former Fort Ord). While the reclamation of wood by mechanically removing the LBP from the wood was a topic addressed in the overall focus of the earlier projects, it only focused on the siding and did not consider other wood materials from the buildings and the associated costs. This demonstration, by contrast, investigated all significant potential sources for reclaimed lumber available within the barracks targeted for demolition as well as total building removal and salvage costs.

Specifically, this demonstration considered all dimensional lumber taken from the barracks. All wood painted with LBP was machined into blanks for reprocessing, and all available unpainted wood was concurrently recovered. Unpainted lumber whose value could be increased by the planing process were also milled. This latter aspect of the demonstration was intended to explore additional options for optimizing the value of recovered wood, thereby increasing the overall economic benefit of the wood reclamation process.

The current generation of AMI Yield Pro equipment was developed for use by lumber mills and pallet recyclers to reclaim scrap wood and old pallets for reprocessing into value-added wood products. Ordinarily, lumber mill scrap and old pallets are ground up and used for fuel or low-value products such as mulch (Figure 2.11). At the time of this demonstration, AMI operated more than two dozen Yield Pro devices in commercial use; and Baywood Products, Inc., Robertsdale, AL, ran several thousands of pieces of dismantled pallets every day with boards containing embedded nails. In 2002, while working with the Fort Ord Reuse Authority (FORA), trial runs were made using the YieldPro to remove LBP from siding boards and to resize them. The rectangular boards were then reshaped using a planer/molder into another tongue-and-groove flooring boards and other profiles. See Section 3.5 for a list of accomplishments from that effort.

Figure 2.11. A low-value reuse option for recycled wood materials.

2.3 Factors Affecting Cost and Performance

Factors that affect cost and performance of this demonstration parallel those that affect the success of a small construction project. The process involves removing barracks by taking them apart and running the wood through the MU. The timing of materials supply, processing rates, and marketability are important cost and performance factors. Variables affecting those factors are listed below:

- Planning and design regarding project execution
  - project planning
  - process scheduling
  - piggybacking onto a broader program (e.g., demolition)
- Equipment must be utilized to minimize idle time
  - commercial availability of proprietary milling hardware
  - vehicles
  - other machinery or tools
- Logistics
  - mobilization
  - setup and operations
  - demobilization
- Availability and suitability of source materials
  - location of original buildings
  - quality of wood under the LBP
  - amount of wood to justify the investment
- Operations
  - processes
    - collection of raw materials
    - selection of staging areas
    - milling sequences
    - production rates
    - transport and handling of goods and waste
    - capacity of machine (likely to exceed the rate at which raw materials are provided for it, therefore getting the materials to the machine quickly enough is a factor — minimize idle-time for machines)
  - labor force
    - skilled
    - unskilled
- Maintenance
- Safety and security
  - Federal, state, county or laws and codes (EPA, OSHA, other)
  - handling and disposal of LBP
    - working environment external to machine
    - working environment within the machine
- Markets
  - assessment and evaluation
    - range of products
    - competition in same product area
    - desirability
    - forecasting
    - local vending capabilities
  - execution

    - investment strategy
    - mode/venue of sale (e.g., auctions, shelved goods)
    - moving goods to market
- Administrative and business practice
  - paradigms do not exist in current business practices
  - learning curve (scheduling, supply, design, engineering, construction will have to adjust on-the-fly; not a straightforward one to one replacement
- Contingencies / barriers
  - physical
    - enough material to warrant setup and operations? (worth the effort?)
    - unsuitable wood species
    - poorly maintained
    - poor condition, rotten, infested
    - history of fire
    - poor climate
  - local site conditions
    - not accessible
    - unable to protect neighborhood
  - market conditions
    - supply outpaces demand or vice versa (makes marketing less feasible)
    - fluctuations in demand nation wide and locally (not uniform)

2.4 Advantages and Limitations of the Technology

The principal advantages of the technology were found to be as follows:

- commercial availability
- reduction of overall costs of landfilling C&D debris
- solves a costly pollution prevention problem for the Army and DoD
- technology is mobile and self-contained
- generated lead wastes are dry, concentrated, and easily packaged for disposal
- unskilled labor can be used for deconstruction, reducing labor costs
- lack of competitive technologies for this kind of recovery

The limitations of the technology were found to be as follows:

- the required careful deconstruction procedures add labor costs
- MU can process only one board at a time
- assessment for optimal profiles requires hands-on inspection and qualified judgment
- skilled labor is required to operate machinery at the inlet and outlet work stations
- handling of LBP shavings and scraps is regulated by mandates on hazardous waste.

3. Demonstration Design

3.1 Performance Objectives

This demonstration was designed to reveal quantitative data and qualitative information pertaining to the following demonstration objectives:

1. Demonstrate, evaluate, and document a self contained and mobile process to safely, mechanically, and economically retrieve wood materials onsite from obsolete buildings.
2. Demonstrate, evaluate, monitor, and document the entire scope of this process for safely handling and disposing of LBP in an environment, manner or scale which has never before been commercially achieved.
3. Demonstrate, evaluate, and document the reduction in volumetric burden upon hazardous and/or nonhazardous waste landfills that may result from this technology.
4. Demonstrate, evaluate, establish, and document (local) market parameters for the recovered wood products.
5. Demonstrate, evaluate, validate, and document market parameters by capitalizing on the value of the recovered wood materials through optimum (local) market venues.
6. Demonstrate, evaluate, and document the advantages and disadvantages for economic, environmental, and operational aspects for the life-cycle of the process and technology (in terms of time, cost, quality, and safety). Include regulatory, legal preparation, logistical setup, deconstruction, wood sorting, milling, hazardous and nonhazardous waste disposal, optimal wood profiles for high-quality and high value wood products, optimal marketing strategies and parameters, logistical break-down, and clean-up operations. Include takeoff and characterization of each building in-place; inventories and values of the reclaimed and recycled materials; a description of the material salvage and reclamation processes; costs incurred to salvage and reclaim, recycle, and dispose of the building materials; waste disposal characterization data; air monitoring data.
7. Demonstrate, evaluate, and establish the levels of lead concentration that remain in wood after the LBP has been removed. (Because there is no explicit current guidance dictating permissible levels in the recovered wood, allowable levels must ultimately be established and defined.)
8. Demonstrate, evaluate, establish, and describe the needs and requirements for existing and/or new or altered codes, regulations, and or standards in order to make the process and technology open and accessible as well as the products produced by the technology marketable.
9. Document lessons learned and recommendations for that which is not included above.

The objectives are summarized in Table 3.1.

The equipment and processing were set up and operated in the same conditions, manner, and scale as would be expected for similar real-world projects at military installations. Experienced equipment operators were used to minimize any learning curve that might negatively skew the cost data. The deconstruction and materials-handling operations were documented. During op-

erations, enhancements were explored to maximize procedural and equipment efficiencies, from board removal techniques to the steps necessary for making high-value finished products. An independent cost/benefit analysis addressing equipment use, maintenance costs, deconstruction procedures, and waste disposal was performed to verify the recorded results.

Table 3.1. Performance objectives.

Type of Performance Objective	Performance Criteria	Expected Performance	Actual Performance
Quantitative	Net cost	Less or equal to $12/sq ft of building	$12.01/sq ft not incl contractor's claim; $15.49/sq ft, incl. contractor's claim
	Time: project schedule	Remove building in no more than 6 work days	8 work days / building
	Time: productivity	Process 9,000 lf of clean wood products per day	11,240 lf / day
	Quality: waste reduction/landfill diversion	Divert 60% or more from landfilling	80.30% reduction in landfill burden
	Quality: marketability of salvaged materials	Market 50% or more of salvageable wood	71.60% of wood sold
	Safety: accidents	Zero reportable accidents	1 lost time accident discovered by ERDC-CERL
	Safety: airborne lead dust	Prevent airborne lead concentrations approaching 30 ppm within 100 ft. of MU	Non-detectable levels outside MU; 30ppm within unit
	Safety: lead concentration in processed wood products	Limit residual lead in cleaned wood products to less than 600 ppm	<6 – 34 mg / kg detected at wood surface
Qualitative	Product quality: marketability	Interest by local mills & lumber dealers	Lukewarm interest because of low volume. Interest by dealers if greater quantities are available
	Safety: LBP handling	Comply w/ all applicable regulations; no NOVs	No violations
	Regulatory guidance:	Develop recommendations for EPA/DoD/others for LBP-coated materials' handling	Results of characterization are being incorporated into Army Public Works Technical bulletin

3.2 Selection of Test Site and Facilities

The prime location for this demonstration was Camp Roberts, a large California Army National Guard installation in west-central California.

3.3 Test Site/Facility History and Characteristics

Congress authorized funds for the purchase of land and building of training sites in 1940. The 42,784 acres that comprise Camp Roberts have served as a training installation and as an out-processing center for hundreds of thousands of soldiers during WWII, the Korean War, and the Vietnam War. At its peak of activity, Camp Roberts ranked among the world's largest military training centers. Camp Roberts was officially closed by the Army as a training installation in April 1970, and on 2 April 1971 it was reopened by the California Army National Guard, under a license from the Army, as a Reserve Component Training Center. Today the mission of Camp Roberts is to facilitate the training, mobilization, and security of the National Guard, Army Reserve, and active component units in support of Federal, State and community missions.

Camp Roberts was selected as the demonstration site because there was a high degree of support for the project and the installation has many WWII-era barracks that are ready for removal. Because the excess barracks are unoccupied and out of the way, the work could be performed without interrupting daily camp operations. Also, the contractor selected for removing the LBP from the salvaged boards is located near the site.

Another reason for selecting Camp Roberts is that the installation experienced problems in disposing of lead-contaminated wood during previous building removal activities, so a successful demonstration would concurrently solve a pre-existing problem. The Camp Roberts DPW had recent cost data for those building-removal activities, and that information was highly beneficial in performing cost analyses for comparing the various deconstruction options and validating the benefits of the technology being demonstrated. There are between 600 and 700 WWII-era wooden buildings that will need to be removed because of future new construction that is expected. More information about Camp Roberts is available at http://www.calguard.ca.gov/cprbts/.

3.4 Present Operations

As noted previously, Camp Roberts is operated today by the California Army National Guard, serving primarily as a Reserve Component Training Center but also as a training resource for all U.S. uniformed military services as well as those of certain allied nations.

The Camp Roberts waste disposal program is typical for Army installations. The installation maintains its own landfill, which contains some LBP, and has filed a request with DTSC to expand the landfill in order to dedicate a portion to LBP-contaminated materials. (That decision was still pending at the time of this writing.) The closest authorized hazardous waste landfill is 65 miles away, at Kettleman City, CA. The closest nonhazardous landfill is located 30 miles from Camp Roberts, at Atascadero, CA. Tipping fees for offsite RCRA C&D waste disposal have been calculated at $1,200/ton ($120/cy, assuming about 10 cy/ton), and tipping fees for non-RCRA C&D waste at $65/ton. The $1,200/ton RCRA tipping fee is a conservative estimate that assumes a well packed waste container. A less-well-packed container would equate to higher total costs because the rate is based either on a price per cy or per weight, whichever dollar amount

is higher. The higher the total costs for disposing of RCRA wastes, the more economically beneficial will be the demonstrated waste diversion and salvage process.

Because the buildings and the area used for the demonstration project were unoccupied and located remotely from daily installation operations, there were no receptors to airborne lead within thousands of yards of the work area. However, there is no Standard Industrial Classification that corresponds to deconstruction activities or the recovery operations demonstrated in this project.

3.5 Pre-Demonstration Testing and Analysis

In 2002, obsolete WWII barracks coated with LBP were, respectively, deconstructed at Fort Campbell, KY, and demolished at the former Fort Ord, CA. Prior to the scheduled deconstruction/demolition, sample siding was taken from five buildings at Fort Campbell and processed by the USDA Forest Products Laboratory (FPL) at Madison, WI. At Fort Ord, sample siding was taken from 26 buildings prior to their demolition and milled using the WWD MU; some of the wood was also shipped to FPL. The research on safe, mechanical removal of the LBP and remanufacture of the recovered wood into saleable products produced positive results[7]. The process was evaluated using both the MU and an indoor laboratory workshop environment. The highlights of those tests are summarized below:

- Drop 105 pattern wood siding salvaged from military buildings can be successfully remanufactured into value-added products using equipment commonly found in the new and used woodworking machinery market.
- When properly sized and specified, commonly available woodworking dust collection systems can be used to safely filter and collect waste LBP shavings and dust from machining operations of wood coated with LBP.
- An evaluation of three product profiles, including tongue and groove (T&G) flooring, V-groove paneling, and bevel siding indicated that all could successfully remanufactured from the ¾ in. thick salvaged wood siding. It was concluded that T&G flooring is a promising product, as short pieces of siding can be utilized.
- It was notable that instead of decreasing the products' value, the presence of nail holes universally increased the value of the wood by providing a "rustic" or "environmentally stylish" character. Additionally, the nail holes present in the salvaged siding may not significantly affect the market value of the T&G flooring.
- An evaluation of the Douglas fir siding from the former Fort Ord and the Southern Pine siding from Fort Campbell indicated that about 1/3 of total length was lost to end trim, splits, and other defects.
- The siding salvaged from the former Fort Ord contained far less wood decay than the siding salvaged from Fort Campbell. The primary reason is likely the dryer seasonal conditions

[7] Falk et al. 2006.

(wood dryness) associated with the Fort Ord location. Surface checking and end-splits in the former Fort Ord siding were less frequent than the siding salvaged from Fort Campbell.

- As much as 50% of the weight of the salvaged from the former Fort Ord siding can be saved from landfill disposal by remanufacturing into T&G flooring (i.e., only 50% of siding ends up as waste). Savings are somewhat lower for other profiles and for the Fort Campbell siding, due to their greater width. As the finished milled product is a standard width (3 1/8 in. flooring, for example), any feedstock material in excess of that width is trimmed and wasted. For example, more material is wasted from a reclaimed 8 in. siding board than from a 6 in. siding board.
- An estimated market value for Douglas fir flooring produced from the siding from a typical single story Fort Ord barrack is calculated to be at least $2,500.
- It is estimated that the remanufactured Douglas fir millwork would have a potential producer sale value of about $1.20 bf to $1.90 bf. For market comparison purposes, commingled Southern Yellow Pine millwork produced from salvage would have had only about half of the resale value of Douglas fir (about $0.80 bf) at the time of the survey (Falk et al. 2006). The Camp Roberts project did not include any Southern Yellow Pine, but it is a common species in WWII-era wood buildings located elsewhere.

3.6 Testing and Evaluation Plan

Because building removal is in essence a construction project, the demonstration was conducted as such. Considering that the objectives of the project were to demonstrate the viability of the technology, the metrics of interest were time, quantity, quality, unit costs, and overall project cost.

3.6.1 Demonstration Setup and Startup

The demonstration site, from which three adjacent buildings were removed, was characterized by features similar to that of a small construction project. The work area was set up by cordoning it off and sectioning it for materials staging and processing. The only major piece of equipment, other than a man-lift, was the self-contained MU; conventional hand tools also were used.

The startup process encompassed the following considerations, equipment, and services:

- Sited on Camp Roberts at a location near the buildings to be demolished
- Temporary facilities
  - admin field office (project management, records)
  - telephone
  - toilet facilities
- Mobile milling unit
  - trailer as pictured in Figure 3.2, Figure 2.9, and Figure 2.10
  - safety and security

    - maintenance description (milling machines as needed; no support from Camp Roberts required for maintenance)
- Disconnect utilities (Camp Roberts responsibility)
    - disconnect electric
    - disconnect water
- Utilities (contractor responsibility)
    - provide water (fire, dust suppression)
    - provide water (potable – coolers)
    - provide electricity (machines, power tools)
- Staging areas (segregation piles, pre-milling, post milling, C&D waste, recycling, other)
    - near deconstruction areas
    - near machines
    - near water (fire)
    - near waste bins
    - other
- Vehicle parking
    - overnight
    - number and description of vehicles
    - security provided by Camp Roberts
- Signage
    - no unauthorized personnel
    - test in progress
    - no dumping
    - safety office
    - other as required by site conditions
- Provide protection
    - land areas: preserve land areas outside the limits of the work area in their present condition
    - trees and shrubs
    - water resources: control disposal of fuels, oils, bitumen, calcium chloride, acids or other harmful materials, both on and off the government premises.
    - dust control: water sprinkling
    - erosion control: temporary erosion and sedimentation control for exposed areas subject to erosion due to rainfall
    - under/above ground utilities
    - fencing around work areas (4 ft high orange plastic snow fencing is acceptable)
    - tools and equipment storage (locked in facility provided by Camp Roberts)
    - overnight vehicle parking

3.6.2 Planer Mobilization and Setup

All required permits and fees were handled by the contractor. The contractor was required to disconnect all utilities from the barracks and remove friable asbestos before work began. Moving and setup of the mobile wood planer was completed in a few hours.

3.6.3 Period of Operation

The original ESTCP Demonstration Plan included an expected startup date for onsite activities to begin in May 2004. However, a difficulty developed between WWD and Auburn Enterprises — the constituent businesses that had formed a partnership under the name USA Recovered Resources (USARR) to bid on the project contract. USAAR ultimately was not able to fulfill the contract, and neither WWD nor Auburn were able to perform the work alone. Consequently, ERDC-CERL was compelled to terminate that contract at the convenience of the Government and seek other solutions at a late date in the project schedule. A designated 8A contractor, Ahtna Government Services Corporation, West Sacramento, CA, was identified as an alternative contractor given that the company met the experience requirements and had a previously established working relationship with WWD, the owner of the MU. The Demonstration Plan was then revised to accommodate a projected startup in early 2005.

3.6.4 Amount/Treatment Rate of Materials to be Treated

Materials were salvaged from about 14,400 sf of WWII-era barracks. The primary source of wood was siding, dimensional lumber framing, blocking and bracing, sheathing boards, and flooring from three two-story Type 1A Barracks measuring approximately 30 x 80 x16 ft (Figure 3.1). Deconstruction was performed by Ahtna Government Services Corporation (AGSC), West Sacramento, CA, the project primary contractor. The planing operation to remove the LBP was performed by WWD as a subcontractor/partner. All feasible materials from these barracks were recycled but the focus was on reclamation of the painted wood. (See Table 3.2 in Chapter 3 for a description of the lumber that can be found in a typical WWII-era barracks building.)

Figure 3.1 Typical WWII barrack at Camp Roberts.

The wood used to construct WWII-era barracks, such as those found at Camp Roberts, is characterized in Table 3.2. Given there is some wood that is already damaged or otherwise unsuitable for reprocessing, and given recovery rates based on recent tests of the MU at the former Fort Ord, these data suggest that 71% of the wood materials (by weight) can be recovered and sold as a milled product. Of approximately 40 tons of wood material in one such barrack, up to 28 tons should be recoverable and available for sale as milled products. Damaged or deteriorated wood not contaminated with LBP can be ground for mulch, further increasing the total wood materials diversion rate.

Approximately 19,000 lf of siding and approximately 7,900 lf of interior finish boards are available in three two-story barracks. In total, approximately 53,000 lf of millable feedstock, both painted and unpainted, can be recovered. Of approximately 26,900 lf of painted siding and interior finish boards available, 22,480 lf were actually processed through the mobile planer.

The MU can mill up to 50 lf/minute (lfm). The duration of continuous operation of the MU is governed by the emissions of its diesel-powered generator. Prevailing MBUAPCD rules and local conditions limited continuous operation to a maximum of 6 hours/day. Assuming an average feed rate of 25 lfm (linear feet/minute) over 6 hours (including downtime), 9,000 lf of feedstock could be processed in a workday. The MBUAPCD permit allowed up to 24,000 lf to be processed per day, which was more than adequate to mill all usable painted stock hypothetically available in the barracks.

Table 3.2. Wood materials data for typical two-story WWII-era barrack (approximately 80 x 30 x 16 ft).

Wood Item	Quant	Unit	% LBP	Stand (lf)	Stand (bf)	Wood Salvage Painted 66% (bf)	Wood Salvage Unpainted 75% (bf)	Wood Waste (bf)
1x4 T&G (1)	2409	sf	60%	7227	2409	954	723	732
1x4 T&G (2)	2409	sf	50%	7227	2409	795	903	711
1x6 Diag Sheathing (1)	2409	sf	0%	4818	2409	0	1807	602
1x6 Diag Sheathing (2)	2409	sf	0%	4818	2409	0	1807	602
1x4 Bridging	960	lf	0%	960	320	0	240	80
1x6 Novelty Siding (ext)	3196	sf	100%	6392	3196	2109	0	1087
1x8 Skirting (ext)	264	sf	100%	396	264	174	0	90
2x10 Joists (2)	1175	lf	0%	1175	1958	0	1469	490
2x4 Ceiling Furring (2)	242	lf	0%	242	161	0	121	40
2x4 Framing (1)	1318	lf	50%	1318	879	290	330	259
2x4 Framing (2)	1632	lf	50%	1632	1088	359	408	321
2x4 Stud Framing (ext)	1434	lf	100%	1434	956	631	0	325
1x4 T&G Veneer Paneling (1)	500	sf	50%	1500	500	165	188	148
1x4 T&G Veneer Paneling (2)	378	sf	50%	1134	378	125	142	112
2x8 Rafters (2)	1338	lf	0%	1338	1784	0	1338	446
2x6 Joists (1 perimeter)	220	lf	0%	220	220	0	165	55
2x6 Joists (1)	1413	lf	0%	1413	1413	0	1060	353
2x6 Joists (roof a)	632	lf	0%	632	632	0	474	158
2x6 Joists (roof b)	515	lf	0%	515	515	0	386	129
2x8 Beams (1)	1179	lf	0%	1179	1572	0	1179	393
2x8 Beams (2)	482	lf	0%	482	643	0	482	161
6x6 Columns (ext)	296	lf	100%	296	888	586	0	302
Eyebrow 1x10 Sheathing	792	sf	100%	950.4	792	523	0	269
Eyebrow 2x4 Rafters	676	lf	100%	676	451	297	0	153
Sheathing (R)	2611	sf	0%	5222	2611	0	1958	653
Totals				53196	30857	7008	15180	8671
				lf	bf	bf	bf	bf

3.6.5 Residuals Handling: Onsite Waste Control

Areas on the ground surrounding the subject barracks were covered with heavy polyethylene film to ensure no lead-contaminated materials came into contact with the ground and to segregate the materials harvested in the deconstruction. Non-wood materials, fixtures, and hardware were separated. Non-recoverable (decayed or damaged) wood was discarded as either hazardous or nonhazardous waste depending upon its content of commingled LBP. Painted wood (all paint is assumed to be lead-containing) was segregated from unpainted wood. A denailing station was set with pneumatic denailers, and as an added measure for safety, the wood was inspected visually before planing. The demonstration plan called for all LBP-coated wood to be milled. The LBP shavings and scrap were isolated from the blanks and stored in appropriately lined containers.

The MU is equipped to capture all lead dust generated by the milling of LBP from the recovered lumber. The RCRA waste was handled and disposed of at the Kettleman City landfill, and the nonhazardous waste was handled and disposed of at the Atascadero facility. Shaving samples were collected, and air quality was monitored near and around the MU and analyzed for lead content.

The contractor was responsible for measures to prevent unrecovered materials, debris, rubbish and other waste materials from becoming a nuisance or hazard within designated areas both during the project and after its conclusion.

3.6.6 Operating Parameters for the Technology

Operating parameters were the same as expected for a small construction project. AGSC was primarily responsible for deconstruction and removal of the barracks, and WWD was primarily responsible for the wood reprocessing operations. AGSC had primary responsibility for marketing the recovered wood. USACE maintained a continuous presence on the site with personnel from Mobile District, and ERDC-CERL sent onsite representatives during most of the field deconstruction and wood recovery activity. The process and data collection were monitored and audited by the University of Florida Center for Construction and Environment (UFCCE) and FPL.

3.6.6.1 Mobilization and Demobilization Activities

AGSC met with the Camp Roberts personnel to assure mutual satisfaction with the project's safety and environmental health plans, and a meeting on the same topic was conducted prior to final site evacuation after breakdown and cleanup.

The contractors were responsible for selecting a suitable MU worksite with level ground and measuring approximately 150 x 150 ft. A short checklist of procedures preceded startup. The MU was moved as needed for optimal processing logistics. Upon arrival of the MU to the worksite, startup typically takes less than 2 hours.

As a result of consultations with the MBUAPCD, DTSC, CIWMB and the Monterey County health department, a permit for a Transportable Treatment Unit (TTU) was applied for and granted for purposes of the demonstration project. The ESTCP site at Camp Roberts falls under the jurisdiction of the MBUAPCD, and the Authority to Construct permit listed locations where the MU could be operated.

The MBUAPCD was informed of the expected project start date 10 days in advance, during which time the workers and resources were transported to the worksite. A final pre-project meeting was held before work began. Market research was continuous, with many conversations weekly as to the current market conditions. The quality of the material and the recovery rate on the project will help determine the market for the materials.

3.6.6.2 Operations: Labor and Equipment

A five-person crew deconstructed the barracks, segregated the materials according to the demonstration plan, and moved the wood to the mobile planing unit. During deconstruction the materials were segregated according to whether they were candidates for wood recovery, non-wood recycling, or C&D debris. Wood components were denailed and separated as painted or unpainted and placed on carts or sawhorses to be transported to the feed staging side of the MU. It was estimated that an experienced seven-person crew should be able to remove and de-nail the siding from a standing building in a day (see Section 4.2.1 for actual production values). A scissors or other suitable man-lift was considered necessary for the gable end, and a rolling scaffold or suitable moving platform was considered necessary for the sidewalls. Siding, skirt boards and trim boards should be removed carefully and sorted to width and length.

The MU included a source of compressed air for the operation of pneumatic “nail kickers” that remove the nails from the lumber. Additional screening for embedded metals was also performed, but it was not a prerequisite for the deleading process. To ensure the most efficient use of the MU, the crew’s goal was to supply the siding to the planer in a continuous stream from the start of operation.

AGSC accounted for a total of 2,396 labor hours to remove the buildings, process the wood products, and leave the site in the appropriate condition. That total includes training and all other construction-related activities not directly related to deconstruction and wood processing, such as training, abatement, and sitework. The task consuming the greatest number of labor hours was removing the siding from the buildings, which required 1,040 labor hours — considerably more than ERDC/CERL had expected.

3.6.6.3 Wood Processing

Boards of similar widths were grouped together; all available boards of a given width were processed in a single run. The MU can process boards of any length, but the feedstock was also presorted by length to facilitate later sorting of the processed wood. Adjustments to machining

width and board thickness require entry to the MU. When adjustments were necessary, a short shutdown sequence was followed to prevent any fugitive dust releases. The HEPA filtration system was run during equipment shutdown to maintain the negative air pressure within the MU while adjustments were made. Adjustments typically required about 30 minutes to complete.

Permissible levels of airborne lead resulting from deconstruction and material processing activities were determined by the MBUAPCB per the California Environmental Protection Agency Air Resources Board *Risk Management Guidelines for New, Modified, and Existing Sources of Lead*. MBUAPCB counseled the contractor on the appropriate monitoring and sampling procedures required.

Previous tests have shown variations of residual lead concentrations at various depths of the recovered wood but are generally significantly lower than 600 ppm which is the target threshold of most legislation (see Table 2.1). A conservative depth (greater than 0.10 in.) was used during the demonstration to restrict lead residues on the final product to minimal levels (less than 50 ppm).

An MU operating team consists of one qualified operator and laborer on the feed side, and whatever number of laborers is needed on the sort side to keep up with unit output (Figure 3.2). Typically the output would be sorted by length, wrapped, and banded for transportation to another site for finish milling.

Figure 3.2. MU in operation, showing a representative crew size.

As previously noted, MU continuous operation was limited to 6 hours/day because of environmental restrictions on diesel exhaust emissions from the unit's electricity generator. This would suggest a maximum daily quantity of about 9,000 lf, assuming a feed rate of 25 lfm. However, the design parameters of the MU allow for a faster feed rate; the optimum speed is determined by

the feedstock species, quality, and the end-use potential of the material. A higher quality of feedstock may allow for a more aggressive feed and, as a result, increased volume of processed wood.

AGSC required 280 labor hours to denail and process the 22,480 lf of siding and interior finish boards removed from the buildings. Of that, 238 labor hours were required to denail, sort, and handle the boards prior to planing, and 48 labor hours were spent actually running the boards through the MU. A crew of four ran the MU for 6 hours each of 2 days.

3.6.6.4 Other Deconstruction Materials

It was anticipated that some wood would be too decayed to process or recycle, but most recovered wood was expected to be reusable or recyclable. Contamination concerns, logistics, and local economics determine the final fate of each material. Asphalt shingles are recyclable, but if they are contaminated with asbestos they must be handled as hazardous waste even though not explicitly defined as such by RCRA. Rotted, split, or otherwise unsuitable lumber was recycled as mulch. Ferrous and non-ferrous metals were intended to be recycled, and architectural hardware was assessed in terms of its value either as salvage or for recycling.

3.6.7 Experimental Design

Planning and monitoring the workflow from deconstruction to milling to market sequence were central to the execution of this demonstration. This project represents the first time that all lumber from a deconstruction project was considered for recovery and resale; previous projects involved only the recovery of 1x8 siding boards. The economic benefits of the process (i.e., revenues in excess of costs) were considered to be a key success criterion. Benefits of the proposed process were compared with the standard practice of demolition and landfilling. The economic benefits of diverting waste from landfills were estimated, and all parameters involving time, cost, productivity, quality, and safety were observed and recorded. The following elements were key demonstration design considerations:

- Equipment (time, cost: setup, operations, maintenance, idle time, safety)
  - tools
  - WWD MU
- Materials handling, segregation, and staging
  - optimal sequencing
  - pre-milling assessments
  - post-milling assessments
  - post-milling marketing
- Quality assurance monitoring
- Health and safety plan execution.

3.6.7.1 General Site Requirements

As previously noted, the worksite was set up in close proximity to the barracks targeted for deconstruction; see Section 3.6.1 for more. Milling operations by the MU are essentially indoor activities because the unit is a closed system operating under negative air pressure. Aside from administrative work, the remainder of the project activities were performed outdoors. The site was divided into staging and operational sections according to the established project requirements for observation, monitoring, record keeping, deconstruction, and wood recovery operations.

The required staging areas were established for deconstructed materials segregation into recoverable wood, hazardous and nonhazardous C&D debris, pre-milling evaluation, post milling operations, recycling; and post recovery marketing of the wood materials. The buildings were be deconstructed onsite.

3.6.7.2 Accuracy and Validation of Research Data

UFCCE and FPL were responsible for ensuring that an accurate and consistent record was kept, and also for validating the test results. UFCCE monitored and verified productivity data, and FPL was retained to monitor and verify the characteristics of the wood materials and the characteristic and value of the marketed materials.

3.6.7.3 General Operations: Materials Recovery, Processing, and Adding Value

Building deconstruction proceeds in the reverse order of building construction. First the siding is removed, followed by removal of the non-bearing walls and framing, then deconstruction of the roof, structural framing, flooring, and finally removal of all foundation support such as cellars or concrete piers. After the building has been removed, all holes are filled and the ground is cleaned up, compacted, seeded for grass or otherwise prepared for subsequent use. During the process, recovered materials are segregated as described previously.

The procedure for identifying the best and highest-value reuse of each wood material was based mainly on expert and experienced judgment provided by the contractor, ERDC-CERL, UFCCE, or FPL. To the greatest extent possible, the intent of the demonstration was to sell all materials for reuse in their existing form or processed to increase their value. Materials not feasible to reuse were routed either to recycling or disposal under approved methods.

The exterior siding of the buildings at the project site is the primary source of lead contamination, but LBP was also found on interior trim, wall cladding, and framing. As previously noted, LBP-coated wood was sorted for the deleading task. Wood coated with asbestos-containing mastic had to be re-sawn to remove the asbestos intact for disposal in a certified hazardous waste landfill. All recovered wood was evaluated in a follow-up process to determine its suitability for further processing onsite into value-added products.

3.6.7.4 Demonstration Data Requirements

Demonstration data requirements were established in the performance plan. The following text briefly states and describes each requirement.

Building Characterization. Characterize each building to be demolished. Include a takeoff of all materials present in the standing buildings, and asbestos, ACM, LBP, and hazardous material surveys.

Regulatory Requirements. Describe regulatory requirements applying to the building's salvage activities, and the materials recovery and reprocessing activities. Include occupational and environmental regulations and provisions specifically applicable to the handling of LBP materials and the control of LBP.

Documenting the Materials Recovery Process. Describe the materials recovery process. Include the following:

- Salvage Tasks, Sequences, Resources. Building salvage tasks and activities, sequence and duration of each task, and the labor and equipment resources applied to each task. Include the daily reports. Summarize the deconstruction timeline by the rate of work accomplished (productivity) at each task and per sf of building.
- Reclamation Tasks, Sequences, Resources. Material reclamation tasks and activities, materials flow, sequences, and labor and equipment resources applied to each task activity. Describe the items produced from the process. Summarize the materials processing timeline by the rate of production of each type of material processed.

Recovered Materials. Describe the recovered materials. Include the following:

- Reuse As-Is. Inventory of materials, by type and quantity, recovered from the buildings' salvage for reuse as-is, for feedstock to reclamation processing, and for recycling. Identify the species and grades of wood materials. Include the condition of the recovered materials.
- Reuse After Processing. Inventory of materials, by type and quantity, produced through the reprocessing.
- Value. Value of reusable, reprocessed, and recycled materials, by unit price and total; value. Provide actual process of sold materials and estimated market process for unsold materials.

Recovery Costs. Compile all materials recovery costs. Include the following:

- Direct Labor. Direct labor and equipment costs and indirect (or job overhead), which may include but are not limited to permit costs, supervision and management, operating ex-

penses, expendable materials, and disposal costs. Alternatively, provide the data from which these costs can be compiled.

- Deconstruction. Summary of deconstruction costs per task and per sf of building.
- Recovery and Processing. Summary of recovery and processing costs per unit of each type of material produced.

Waste Disposal. Compile waste disposal data. Include the following:

- Waste Characterization. Provide waste characterization data required by the prevailing jurisdictions. These may include but are not limited to surface lead concentrations, total lead, RCRA TCLP, and Cal-Wet test results.
- Hazardous Waste. Describe, by type and quantity, hazardous materials removed from the buildings. Identify the facilities where these materials were disposed.
- C&D Debris. Describe, by type and quantity, building debris generated from the salvage and material reclamation processes. Identify the facilities where these materials were disposed.

Air Monitoring. Provide the area and personal air monitoring data developed for permitting the building salvage and materials reclamation processes, as required by prevailing environmental and occupational health and safety jurisdictions.

Test Samples. Make samples available for testing by ERDC-CERL. These may include soil from the building sites, painted and unpainted materials salvaged from the buildings, reclaimed wood materials, and residue and waste materials generated by the wood reclamation process.

Lessons Learned. Identify lessons learned during execution of the project. These may include building salvage and materials reclamation processes and results; interdependence between salvage and material reclamation methods, activities, sequences, and processes; market conditions; economic results; schedule and productivity issues; quality issues; regulatory issues; and recommendations for improving the wood material reclamation process.

3.6.8 Demobilization

At the conclusion of the demonstration work, the wood products and recyclable debris were transported off site. The remaining inert deconstruction debris was also removed as described above. The site was then graded flat and covered with hay to inhibit soil erosion. The equipment was demobilized and inspected, and a Notice of Completion was executed with the Camp Roberts point of contact. The cleanup and demobilization process took 3 days.

Clean wood scrap and non-wood materials reclaimed from the barracks were recycled as discussed in Section 4.3.1.

Disaster Kleen, Inc., was the licensed and insured subcontractor retained to abate and dispose of hazardous waste. The final repository of the hazardous waste was the Chemical Waste Management facility at Kettleman City, CA. The residual nonhazardous waste from deconstruction and source separation activities was the privately owned Chicago Grade landfill, Atascadero, CA, which is licensed by CIWMB. The Kettleman City and Atascadero facilities are 65 and 30 mile from Camp Roberts, respectively.

The demobilization was greatly simplified because the equipment being demonstrated is mobile. The MU can be packed and ready to move in a morning. The reclaimed wood was moved offsite for value-added processing or sale as blanks. The greatest demobilization effort was put into recovery of the grounds after deconstruction and milling were completed. Holes had to be backfilled, and the soil had to be sifted to remove smaller debris fragments. Finally, the backfill had to be compacted and seeded for grass, or otherwise prepared for subsequent use.

The construction materials recovered in the course of this demonstration became the property of AGSC and WWD, and they retained discretion over the final sale or use of the materials.

3.6.9 Health and Safety Plan

AGSC, with assistance from WWD, was responsible for collecting all data pertaining to the use of the MU and to preparation and marketing of the reclaimed wood. (See section 3.6.7.4 for a description of the data collected.) Data were independently audited. The USDA Forest Products Laboratory focused on the processing and marketing of the reclaimed wood. The primary contractor developed both a quality control plan (Appendix C) and a health and safety plan (Appendix D).

All safety requirements for general construction are also required for deconstruction, in particular:

- OSHA 29 CFR 1926 as pertains to construction safety, especially OSHA 29 CFR 1926.62 with regard to lead
- 29 CFR 1910, which pertains to general occupational health.

Detailed safety plans for general construction, as they pertained to the Camp Roberts deconstruction project, are described in Appendix D. A summary of the plan's operational features follows.

3.6.9.1 General Safety Principles for Deconstruction

The following basic general deconstruction principles were observed:

- Use personal protection equipment (PPE).

- "Last On Is First Off" (LOFO), meaning that disassembly should proceed in the reverse order of assembly for safety purposes in order to avoid removal of load-bearing structural members before the supported construction materials are removed.
- Use the same tool used for construction to remove a given component;
- Use minimal force; let tool do the work.
- Always be aware of body control and position.
- Maintain clear access to building elements and passageways in and out.
- Use fall protection equipment and processes.
- Delineate passageways for people and materials.
- Use staging areas for materials collection and de-nailing/processing.
- Do not overlap worker areas horizontally and vertically with overhead work.

3.6.9.2 LBP Hazmat

Wood boards and other architectural components with "sound, fully adhered LBP" are not hazardous materials, but loose and flaking LBP and contaminated sawdust from the MU are hazardous waste according to EPA and HUD definitions of LBP hazards for target housing. There is no Federal standard or regulation that explicitly defines presence or absence of hazard on salvaged building materials.

After the LBP has been planed away from salvaged wood, the shavings become a hazardous waste. As such, the contractor was a hazardous waste generator and bound by the rules and regulations for the accumulation, shipping and disposal of the waste. The contractor was also responsible for protecting its employees and the surrounding neighborhood from the health hazards of lead in accordance with Federal and state standards.

3.6.9.3 Worker Exposure to Hazmat

Due to the nature of LBP-contaminated debris, inhalation and absorption through the skin are the primary vectors for exposure. Proper hygiene, institutional controls, and access restrictions were employed to reduce human exposure to a minimum.

Safety procedures were also implemented in the design and operation of the mobile wood-processing unit. The MU dust collection system uses a HEPA filtering system and contained storage for the contaminated wood shavings. A HEPA filter is capable of filtering particles as small as 0.3 microns. Previous tests of the MU in 2002 included collection of air quality data, and all safety procedures were verified.

Onsite personnel were required to use personal safety equipment, including HEPA face masks and Tyvek body suits to minimize exposure to LBP dust. Previous air tests around the working MU determined that only personnel within a few feet of the operation require personal safety equipment (Figure 3.3), but all personnel were required to use all safety gear until otherwise de-

termined that lead concentrations at the deconstruction site or surrounding the MU were below OSHA and Cal-OSHA allowable levels.

Figure 3.3. A worker equipped with HEPA mask and Tyvek protective clothing.

3.6.9.4 Physical Requirements for Workers

Workers were required to have the strength and coordination of a typical construction laborer. The use of respirators was not required, but OSHA requirements for airborne lead monitoring were applied.

3.6.9.5 Accident or Breakdown Record

Individual components of the MU are in daily use around the country in many different applications. The only incident of record occurred when the YieldPro discharge chute clogged, requiring hand-clearing. Due to the nature of this work, the use of adequate personal protection equipment such as gloves, safety glasses, and heavy clothes to protect the workers from splinters and chips was enforced.

3.6.9.6 Technology Precautions

The equipment was thoroughly cleaned every day to capture any interior fugitive sawdust. The accumulated sawdust was appropriately packaged and periodically transferred for disposal as hazardous waste. The safety plan called for any spills or releases of dust during handling to be HEPA-vacuumed back into the MU. Transfer and transportation of all LBP debris was done by licensed personnel under strict regulation, manifesting, and chain of custody.

In order to determine the presence of residual lead on the machined wood profiles, lead testing was performed according to ASTM E1278-03, *Standard Practice for Collection of Settled Dust Samples Using Wipe Sampling Methods for Subsequent Lead Determination*. The original siding, the manufactured profiles, and the machinery were all monitored.

Relevant guidance observed included:

- *Lead in Dust Wipes*, http://www.cdc.gov/niosh/nmam/pdfs/9105.pdf
- *Definition of Wipe Sample*, http://www.epa.gov/lead/qa10.pdf
- *Work Practice Standards*, http://www.epa.gov/lead/qa12.pdf

In California, CalOSHA also has a PEL for indoor lead exposure set at 50 $\mu g/m^3$, as averaged over an 8-hour a work shift. They also have an "action level" designated at 30 $\mu g/m^3$. Within the immediate perimeter around the MU, EPA limits 3-month air exposure to 1.5 $\mu g/m^3$. The demonstration was continuously monitored in order to avoid exceeding the CalOSHA 3-month limit.

During earlier testing of the MU system at the former Fort Ord in fall 2002 under similar operating conditions, lead concentrations inside and close to the MU milling area were discovered to be greater than that allowed by OSHA or the EPA. Leaks in the vacuum filtering system were discovered and repaired, and subsequent testing showed that lead concentrations were within allowable exposure limits. Even though the process was shown to operate within and under the allowable lead exposure thresholds, full safety gear was required until it could be concluded that lead concentration levels in the air within the vicinity of the working are within prescribed limits. Monitoring for airborne lead was conducted according to OSHA 29 CFR 1926.62.

3.6.9.7 Impact on Immediate Environment

As previously noted, the deconstruction and milling activity was similar to a construction site, including noise, traffic, and soil disruption. The area was monitored for the need to water as a dust-control measure. The final major impacts of this technology were the intentional removal of blighted structures posing a lead-contamination hazard to the occupants of Camp Roberts, and a one-time reduction in landfill use through the reclamation and recycling of construction materials

3.7 Selection of Analytical/Testing Methods

This project required both skilled and unskilled manual labor for the deconstruction and wood processing tasks. It also required professional expertise for developing optimal market strategies for the finished wood products. Given those requirements, the work was largely the same as what would comprise small construction projects of similar magnitude. With the exception of the health and safety monitoring for lead concentrations, all of the required observations were at a macroscopic scale, performed by eye and documented hand using paper forms and a spreadsheet application. Time measurements were made using a watch, and linear measurements were made using a measuring tape. Apart from the health and safety documentation and analyses, the main

analytical activity related to economic assessment of process investments and costs versus revenues and non-monetary benefits. In short, the analytical methodology primarily amounted to making visual observations, testing for hazardous project byproducts, and documenting project economic parameters in terms of time, cost, productivity, and final product valuation.

Testing for lead in the air was monitored according to OSHA 29 CFR 1926.62. The amounts of lead content in the captured waste were measured using the TCLP and the Cal WET test. More discussion of analytical methods, including the differences between them and the reasons they may return different results, is presented in Appendix B.

3.8 Selection of Analytical/Testing Laboratory

An independent laboratory, National Analytical Laboratories, Inc. (NAL), Fair Oaks, CA, was contracted by AGSC to perform the personnel and air monitoring analyses. Other lead analyses were coordinated through ERDC-CERL using Forensic Analytical Laboratories, Hayward, CA.

4. Performance Assessment

4.1 Performance Criteria

ESTCP performance criteria addressed process effectiveness, efficiency, and safety. The first two categories of criteria were measured in terms of time, cost, and quality (Table 4.1). Criteria for those categories were defined and characterized in terms of the project objectives (Section 3.1).

Table 4.1. ESTCP performance criteria.

Performance Category	Performance Criterion	Performance measure met
Quantitative Measures		
Net cost	Net cost of building removal is less than \$12/sf	No
Time: project schedule	Process: 6 working days per building	No
Time: productivity	Process at least 9,000 lf of clean wood product per day	Yes
Quality: waste reduction and landfill diversion	60% reduction in landfill burden	Yes
Quality: marketability of salvaged materials	Market 50% of recoverable wood material into higher value products	Yes
Safety: accidents	Zero reportable accidents	No
Safety: Airborne lead dust	Prevent airborne lead concentrations from approaching 30ppm threshold within 100 ft of MU	Yes
Safety: lead concentration in processed products	Produce clean wood products with no greater total lead content on the surface than the 600 ppm allowable for consumer-available paint	Yes
Qualitative Measures		
Product quality and marketability	Real-world market demand for old-growth, high-grade wood products	Yes
Safety: LBP handling	Perform all hazardous waste disposal tasks within regulatory provisions	Yes
Regulatory Guidance	No existing measure of acceptable Pb in recovered wood	N/A

4.2 Performance Confirmation Methods

The project-level objective of this demonstration was to safely and economically divert a hazardous waste stream from a landfill in order to reduce the landfill burden and extend the its service life. The performance data collected during this demonstration are listed in Section 3.6.7.4.

AGSC compiled the official performance data. ERDC-CERL personnel were present on site for 9 of the 15 working days to monitor, record, and collect sample data independently of the contractor. ERDC-CERL personnel also audited AGSC's salvage data to verify its accuracy. The Na-

tional Defense Center for Environmental Excellence (NDCEE) was present on site to record deconstruction activities, sequences, and results. They assisted ERDC-CERL personnel in gathering data on salvaged material descriptions and characteristics. The ERDC-CERL and FPL personnel monitored the wood processing and provided an independent assessment of the wood product's value and marketability. Table 4.2 lists performance criteria and confirmation methods.

Table 4.2. Project performance parameters, criteria, and confirmation methods.

Performance Parameter	Expected Performance	Performance Confirmation Method	Demonstrated Performance	Performance Measure Met
Quantitative Measures				
Net cost	Net cost of building removal is less than $12/sf	Labor, equipment & materials costs were reported to ERDC-CERL by AGSC. Payroll & expenditures were monitored by USACE Mobile District QA Representative.	14,160 sf of building removed at $219,309, or $15.49/sf	No
Time: project schedule	Process: 6 working days per building	Daily reports were submitted by AGSC describing schedule and progress. Schedule & progress was documented per field observations by ERDC-CERL & NDCEE personnel.	3 buildings were deconstructed in 24 work days = 8 work days/building	No
Time: productivity	Process at least 9,000 lf of clean wood product per day	Daily reports were submitted to ERDC-CERL by AGSC describing schedule and progress. Schedule & progress was documented per field observations by ERDC-CERL & NDCEE personnel.	22,480 lf of siding was processed in two 6- hour work days = 11,240 lf/day	Yes
Quality: waste reduction, landfill diversion	60% reduction landfill burden	Bin rental, hauling, & tipping receipts were compiled by AGSC & supplied to ERDC-CERL. ERDC-CERL calculated landfill disposal and diverted quantities.	80.3% reduction of landfill burden	Yes

Performance Parameter	Expected Performance	Performance Confirmation Method	Demonstrated Performance	Performance Measure Met
Quality: marketability of salvaged materials	Market 50% of recoverable wood material into higher value products	Processed wood materials were counted on-site by the MU counter, then verified by piece count by ERDC-CERL personnel. Salvaged wood materials were calculated per ERDC-CERL quantity takeoff, and verified by on-site count by ERDC-CERL personnel.	8.3% of recoverable wood was processed into higher value products; 71.6% of all wood was reused	Yes
Safety: accidents	Zero reportable accidents	health and safety plan reports	No reported or lost time accidents	No
Safety: airborne lead dust	Prevent airborne lead concentrations from approaching 30ppm threshold within 100 ft of MU	Ambient air samples were taken per NIOSH 7082; 8 outside & 1 inside the trailer. Cartridges were analyzed by NAL. 6 personal air samples were taken per NIOSH 7082. Cartridges were analyzed by NAL.	All samples outside MU resulted in non-detectable levels of lead. 30ppm detected *within* the MU.	Yes
Safety: lead concentration in processed product	Produce clean wood products with no greater total lead content on the surface than the 600 ppm allowable for consumer-available paint	Surfaces of intact paint layer, then at depth of 1/16, 1/8, 3/16, & ¼-in depths were tested per EPA Method 3050B/7420.	Residual lead measured at <6 mg/kg to 34 mg/kg	Yes
Qualitative Measures				
Product quality: marketability	Real-world market demand for old-growth, high grade wood products	Market survey conducted by FPL consisting of internet search, lumber dealer & broker contacts, & discussions with five local mills.	Low volume of available finished reduced final sale prices. Inquiries have been received by lumber dealer about availability of greater volume.	Yes

Performance Parameter	Expected Performance	Performance Confirmation Method	Demonstrated Performance	Performance Measure Met
Safety: LBP handling	Perform all hazardous waste disposal tasks within regulatory provisions	LBP-contaminated debris handling & disposal monitored per site observations by USACE Mobile District QA Representative. Debris characterization performed by NAL per EPA SW846 (TLLC) & Cal WET., as required by Title 22, Division 4.5, Chapter 11, Article3, section 66261.24 of the California Code of Regulations Waste manifests were written by Camp Roberts Environmental Division personnel per	All hazardous materials were handled per regulatory provisions	Yes
Regulatory guidance	No existing measure of acceptable Pb in recovered wood	N/A	Results of Pb characterization are being incorporated into Army Public Works Technical Bulletin	N/A

4.2.1 Cost

The criterion for a successful demonstration was an overall lower cost for environmentally compliant demolition and landfilling of dissimilar buildings. Because each building removal project has a unique combination of established conditions and requirements, there is no industry-standard cost formula for demolition. A target cost of $12/sf of building was established as the cost criterion for this demonstration, including the termination of utilities, environmental compliance, building and foundation removal, materials disposal, and site grading and seeding . This target cost was based on recent demolition work at Camp Roberts and demolition of similar buildings at the former Fort Ord, approximately 100 miles to the north of Camp Roberts.

Each of the three deconstructed buildings was 4,720 sf, for a total of 14,160 sf. AGSC was retained to remove the three barracks for $175,364. The company sold reclaimed framing lumber for $3,600, and 800 sf of the remilled siding materials (3,200 lf) for $0.75/sf, or $600. The remaining 19,820 lf of remilled siding remain unsold. Thus, the initial cost (total contracted cost, minus the revenue from the materials sales) was $171,364, or $12.10/sf of building. That amount is less than 1% higher than the cost target, so for practical purposes ERDC-CERL considers the cost criterion to have been met.

It must be noted that after completion of the demonstration, AGSC filed a claim to recover waste disposal costs the company had not anticipated, and was ultimately reimbursed an extra $47,562.50 for that expense. The cost of that claim to the government raised the total price of deconstruction and material processing services to $219,309, or $15.49/sf. However, the circumstances leading to the claim should be considered unusual, and are not to be expected in a typical deconstruction project where potential revenues from wood reclamation and remanufacture are a higher priority by the contractor. This situation is described in detail in Section 4.3.1.

In order to distinguish between tasks specifically involving materials recovery and those ordinarily performed in demolition projects, ERDC-CERL required AGSC to itemize their expenses by task, or at minimum indicate the quantity of resources (materials, labor, and equipment) used for each task so ERDC-CERL could apply appropriate unit costs. AGSC compiled labor hours per task (Table 4.3).

Table 4.3. Deconstruction tasks and labor requirements.

Sequence	Task Description	Labor Hours
1	Mobilization	30
2	Unexploded Ordinance and Base Identification Process	48
3	Asbestos Abatement and Disposal	616
4	Lead Based Paint Abatement and Siding Removal	1,040
5	Final Deconstruction / Disassembly	200
6	Concrete Foundation Demolition	80
7	Denailing and Processing Wood Siding Materials	280
8	Demobilization	96
	Total Labor Hours	**2,390**

AGSC's proposal to ERDC-CERL indicated total hourly labor rates of $58.83 for laborers and $95.34 for the equipment operator / superintendent. Those rates represent the cost to the owner (i.e., the government) for these labor resources.

Discounting the labor hours consumed by unexploded ordinance (UXO) training and asbestos abatement, both of which are required for any building removal method, deconstructing 14,610 sf required 1,726 labor hours. Therefore, the total deconstruction task was accomplished at the rate of 8.5 sf of building/labor hour.

The most labor-intensive task, and therefore the most expensive one for AGSC, was removing the siding from the buildings. A significant portion of this task was to spread polyethylene sheets on the ground around the building to collect falling paint chips, then scraping and vacuuming loose paint off the siding with coverage by a HEPA-filter vacuum (Figure 4.1). This activity consumed 44% of the total labor applied to the project, and 60% of the labor applied to the deconstruction and material recovery activities (i.e., not counting the UXO and asbestos abatement training costs). A reach-type forklift was used to collect and move siding boards once removed from the buildings, but was otherwise a completely manual task. Of the recorded 1,040 labor

hours applied to this task, approximately 24 hours of equipment and operator time were observed by ERDC-CERL personnel. Using the labor rates given above, the labor cost for this task would be $70,531. The reach-fork would cost approximately $3,058, based AGSC's rental rate. Altogether, removing the siding boards cost approximately $73,589, which is $8.47/sf of siding, or $5.20/sf of building (Figure 4.2).

Figure 4.1. Piece-by-piece siding removal.

Figure 4.2. Siding removed; ready for deconstruction.

ERDC-CERL calculated there were 8,688 sf, or 17,376 lf of siding available on the three buildings. Given that 1,040 labor hours were invested in this task, the productivity was roughly 0.12 labor hours/sf of siding (8.35 sf of siding/labor hour).

The actual cost of processing the siding materials was modest compared with the total deconstruction cost. AGSC recorded 280 labor hours to denail (Figure 4.3) and process 22,480 lf of LBP-contaminated boards into clean wood stock. Approximately 17,480 lf of exterior siding and 5,000 lf of interior wall finish boards were processed. These figures represent only 11.9% of the 2,390 labor hours applied to the entire project. ERDC-CERL personnel recorded that processing the boards through the MU required four laborers working two 6-hour days, which is 12 crew hours and 48 labor-hours. The total labor cost was $2,824. WWD rented the MU to AGSC for $1,500, for a total cost of $4,324 to plane the boards, which is $0.19/lf of processed board, or $0.43/sf of board materials in place, or $0.31/sf of building.

Figure 4.3. Denailing reclaimed siding using pneumatic tool.

The remaining 232 labor hours were spent on denailing and handling boards before planing. The labor cost for denailing was $13,649 and the equipment cost was $1,886 for the compressor to power the pneumatic nail-removal tool. Altogether, denailing and handling the siding board materials cost $15,535, which is $1.29/sf of siding, and $1.10/sf of building.

The cost to deconstruct the remainder of the buildings, salvage lumber for reuse, and dispose of the remaining materials either for recycling or landfill disposal was also relatively modest. Once the siding was removed, the forklift tipped the buildings over for disassembly on the ground

(Figure 4.4). The total labor expenditure for this task was 200 labor hours, or 8.4% of the total labor hours applied to the entire project. Of that amount, approximately 24 involved use of the reach-fork equipment. Using the labor rates given above, the labor cost for this task would be $12,642. The reach-fork would cost approximately $3,058 based on a prorated monthly rental rate. Altogether, deconstructing the building, salvaging lumber for reuse, and disposing of the remaining recyclable materials and debris cost approximately $15,700, which is $1.11/sf of building or $0.48/bf of salvaged lumber.

Figure 4.4. Building being pushed over for further deconstruction.

Waste disposal was a significant cost component of this project: $74,974 (actual), or 34% of the total project cost (including the AGSC extra reimbursement after completion of the work). Landfill tipping fees were $53,714, and mobilization and demobilization, transportation, taxes, and bin rental fees amounted to $21,260. The Waste Management Inc. (WMI) disposal facility in Kettleman City, CA, charged by the cubic yard of waste, so packing the receptacles to maximize the weight per volume would be critical to the economics of the project.

A significant amount of uncontaminated wood scrap is generated during deconstruction, and some breakage of recoverable wood is unavoidable. Materials unsuitable for reuse or reclamation — not only wood, but also steel and concrete rubble — were intended to be recycled as part of the demonstration project. Approximately 220 cy of concrete rubble and 180 cy of recovered metals were hauled to the WMI Kettleman City facility for recycling. However, in terms of cost accounting, AGSC's disposal data (i.e., weight tickets, manifests, and invoices) do not distinguish the recyclable material volumes from the other nonhazardous wastes hauled there. Based on their records, AGSC was charged the same amount for depositing the recyclable material as

for landfilling nonhazardous C&D debris. Therefore, no economic or sustainability benefits accrued to the contractor or the government from the recyclables that were landfilled at Kettleman City. However, AGSC did realize some waste disposal savings by hauling approximately 360 cy of clean wood scrap for recycling Mid-State Solid Waste and Recycling in Templeton, CA, instead of landfilling at Kettleman City. The recycling fee at Templeton was $15.34/cy, or $46.01 less than the nonhazardous waste disposal fee at Kettleman City, so AGSC saved $16,563 through recycling.

It also should be noted that recycling wood and concrete for use on-post is common on many active Army installations, as is recycling metals to a local scrap dealer. Turning demolition metals in to the local Defense Reutilization and Marketing Office (DRMO) or the installation's qualified recycling program are also common practices in construction projects. Because no deconstruction materials were recycled on-post at Camp Roberts or in the near vicinity, there was an extra materials handling expense that would not normally occur on an active installation. Had AGSC not been required to haul clean wood scrap, concrete rubble, and metal scrap off post, disposal costs of $17,754 for 760 cy of materials would have been avoided. Had AGSC sold the scrap metal to a commercial dealer, up to $2,000 in revenue also could have been accrued, for a total of $19,754 cost avoidance.

AGSC sold 36,000 lf of framing members in widths ranging from 2x6s to 2x12s, and also as 1x12 floor sheathing boards. AGSC did not remove the nails, so the lumber was made available as it came off the building. From ERDC-CERL's quantity takeoff and onsite observation, the framing members and sheathing boards salvaged and sold by AGSC totaled approximately 33,000 bf. The rule of thumb in the used building materials market is that used materials in good condition should sell retail for roughly half of the comparable new materials, or one-quarter if purchased wholesale. Having not removed the nails, selling at those prices would be optimistic. At the time of deconstruction, the national average price of new 2 x10 lumber was well in excess of $0.55/bf. Therefore, a retail price of about $0.27/bf might be expected, with an implied wholesale price of about $0.13/bf. Having sold 33,000 bf of lumber for $3,600, or about $0.11/bf, the economic return may be considered low, but not unreasonable, as a wholesale price.

Figure 4.5. Salvaged framing (left) and subfloor lumber.

4.2.2 Schedule; Building Removal

A critical issue with deconstructing buildings and recovering material for reuse is whether the deconstruction and materials processing activities can be completed within a reasonable timeframe so not to impede any subsequent activities on the site. After abatement is completed, a commercial demolition contractor would normally remove these types of buildings in 4 – 5 workdays, so that timeframe is considered a *de facto* performance benchmark. However, because no immediate redevelopment of the site at Camp Roberts was planned, the actual time to complete this specific project was not critical to the government, assuming that the schedule did not extend beyond reason.

AGSC began mobilization on 14 March 2005. Diversified Technicians, AGSC's abatements subcontractors, began abatement on Building 2212 on 17 March. Diversified Technicians abated each building sequentially, finishing the third one (Building 2214) on 25 March.

Once a building was certified clear of asbestos, AGSC personnel began removing items from the buildings' interiors in preparation for deconstruction. AGSC began preparing Building 2212 for deconstruction on 19 March, and moved into each of the other two after abatement was complete. Windows, exterior doors, exterior fire escape stairs, and eaves were removed and disposed of as debris because they were contaminated with LBP and could not be recycled, and they had no salvage value. Plumbing, electrical distribution, ductwork, boilers, and water tanks were removed and separated for recycling. Because the barracks were simple, austere buildings, removing these materials was not unduly challenging. Gypsum wall board was removed and disposed of as debris. All three buildings had some preparation and deconstruction activities performed concurrently.

Diversified Technicians began removing siding from Building 2213 on 28 March, and finished on 5 April, taking about 7 work days to complete the task.

The AGSC superintendent intended to disassemble the buildings from the top down, but he became concerned about safety because the barracks lost their lateral stability after the siding was removed. The buildings swayed noticeably when walking on the roof, and placing workers on the roof may have exposed them to a collapse hazard. ERDC-CERL personnel described research conducted at Fort McClellan AL and Fort Chaffee AR where buildings were pushed over and disassembled on the ground. The AGSC superintendent adopted this approach, and tipped Building 2214 on 5 April, Building 2213 on 7 April, and Building 2212 on 12 April. Disassembly of the buildings began on 6 April, and was completed by 21 April. Three buildings were disassembled in 12 workdays.

The total duration of the deconstruction work, including removing interior items and finishes, removing siding, and disassembling the framing lumber was 24 workdays, or an average of 8 workdays per building.

4.2.3 Schedule; Material processing

AGSC began denailing the siding boards on 21 April and finished on 29 April. About 20,000 lf of siding was run through the MU on 28 and 29 April and stacked ready for shipping. As previously noted, the MU was permitted to run only 6 hours/day due to diesel emission concerns. In total, seven 8-hour workdays were needed to complete this task. A processing rate of 10,000 lf/6-hour workday, or 1,667 lf/hour, was achieved.

4.2.4 Quality; Landfill Burden Reduction

Based on quantity takeoffs, ERDC-CERL estimated the total weight of three buildings to be 407 tons. Actual quantities in the standing buildings were verified onsite by ERDC-CERL personnel. Not all materials were recorded by weight during disposal or recycling activities, so a precise actual weight for all materials cannot be documented. However, once the actual quantity of materials was verified, unit weights could be applied to calculate total weights for given materials. Douglas fir lumber was weighed onsite at 2.8 lb/bf. Standard-weight concrete weighs 150 lb/cubic foot. Standard weights of pipe, sheet metal, and common building materials were applied to the quantities. Calculated weights of building materials, therefore, are considered reasonable for calculation purposes.

The actual weight of materials hauled for landfill disposal was recorded at 80 tons. All other materials were salvaged, recycled, or processed. Therefore, 327 tons of material — 88.3% of the buildings' mass — was diverted from landfill disposal.

4.2.5 Quality; Higher Value Material Processing

After completion of the ESCTP demonstration all the deleaded material was transported to Calaveritas Mill (San Andreas, CA). Calaveritas Mill processed a small portion of this material into both paneling and flooring (Figure 4.6) to advertise and further demonstrate the recovery potential of millwork from reclaimed siding.

Figure 4.6. Redwood paneling (left) and Douglas fir T&G flooring (right) milled from a portion of salvaged siding from the Camp Roberts

Working with FPL, a wood expert from Pennsylvania State University visited the Calaveritas mill on 8 – 9 May 2006 to examine and visually inspect the deleaded materials. The inspection was limited to a survey sampling of the Douglas fir and redwood stock available at the mill. Much of material was stored mixed within the other mill inventory which allowed inspection only of a representative sample of the deleaded material within the available timeframe of the visit. A primary goal of the mill visit was to assess the relative qualities of the Douglas fir and redwood. Because less information is available on reclaimed redwood siding than on Douglas fir siding, more attention (e.g., inspection sampling) was focused on the redwood stock.

The survey was conducted to collect information on characteristic grain quality as well as losses due to end defects and deterioration typically found in reclaimed wood. Also visual observations were made on the effectiveness of LBP removal by the planing process, the dimensional consistency of the blanks produced, and their condition for remanufacture into marketable products.

Table 4.4 provides a summary of 57 pieces of deleaded wood blanks that were assessed for quality in terms of characteristic grain features. Over half (64.3%) of the Douglas fir pieces inspected could be classified as vertical grain, which commands relatively higher market values in finished millwork products. With few exceptions, most Douglas fir blanks were 100% heartwood content — also a higher-value characteristic — and approximately 58% were clear (i.e., free of knots). To maximize the number of pieces that could be surveyed, length measurements were rounded to the nearest 6 in.

Table 4.4. Summary of inspected Douglas fir blanks machined from Camp Roberts deconstructed siding.

Grain Quality	Approx. Length (lf)	Piece Count	End Trim Loss (lf)	No. Pieces with LPB
Vertical	580.0	38	14.5	9
Vertical/Flat	72.5	4	2	2
Flat/Vertical	58.5	5	8	1
Flat-Sawn	191.0	10	18	3
Totals	902.0	57	42.5	15

Material losses due to end splits or other conditions requiring end-trimming (Figure 4.7) were observed in a significant number of the 57 blanks surveyed. However, this loss factor equates to 4.7% of the total linear footage. This loss percentage also includes measurements of linear footage with respect to observed lengthwise splitting (Figure 4.8). Little decay from in-service use was found in the blanks, but drilled utility holes were occasionally found (Figure 4.9). Some observed wood discoloration was probably caused by nail corrosion. Of the 57 blanks inspected, 15 had residual LBP remaining after the planing process. Figure 4.11 shows an example.

Figure 4.7. Examples of mitered cuts and end splits that would cause a loss of product yield.

Figure 4.8. Lengthwise split as a defect that would cause a loss of product yield.

Figure 4.9. Utility holes found in a number of surveyed blank pieces.

Figure 4.10. Blank showing residual LBP after planing.

Another common machining problem observed was the creation of undersized blanks. Figure 4.11 illustrates a blank that is nearly 5/16 in. narrower than the target width. The frequency of this machining defect was observed in roughly 25% of the Douglas fir survey sample (i.e.,14 of 57).

Figure 4.11. Produced blank that is too narrow.

In addition, some pieces were too narrow (by less than 0.5 in.), and some were observed to be a full 1/8 in. too thin. More thorough data collection, with thickness measurements along the length of all survey blanks, was impractical to perform within the time constraints. The observed dimensional variations in the blanks are problematic for producing finished millwork patterns of consistent measurements and quality. One cause for the problem may have been tool dulling combined with an excessive feed speed during deleading. However, this problem is not considered serious enough to consider the pieces unacceptable for remanufacture purposes. It amounts to a processing problem that could be addressed through changes in technique in order to provide better dimensional uniformity and control over the processed feedstock.

The amount of heartwood and sapwood is an important quality characteristic in the redwood species, with a higher content of heartwood more desirable. “All heart” — 100% heartwood content — is the highest grade. Note that any produced millwork may contain a different mix of heartwood to sapwood content depending on the amount of material removal applied to produce a specific pattern. Figure 4.12 illustrates observed differences in a higher value clear heartwood and lower value sapwood blanks. The data collected to examine characteristic qualities of the deleaded redwood blanks are summarized in Table 4.5. The data are organized into the following observed sort categories:

1. heartwood (> 90 heartwood)
2. heartwood/sapwood mix (sapwood limited to approximately 10%)
3. sapwood/heartwood (heartwood limited to approximately 10%)
4. sapwood (> 90% sapwood).

Figure 4.12. Mixture of heartwood to sapwood found within the deleaded redwood blanks.

Table 4.5. Summary of inspected redwood blanks after deleading.

		Heartwood				**Heartwood/Sapwood**				**Sapwood/Heartwood**				**Sapwood**			
	Grain Orientation	Total length (lf)	Piece count (#)	End trim (lf)	LBP (#)	Total length (lf)	Piece count (#)	End trim (lf)	LBP (#)	Total length (lf)	Piece count (#)	End trim (lf)	LBP (#)	Total length (lf)	Piece count (#)	End trim (lf)	LBP (#)
Defect and Clear	Vertical	932.5	66	46	13	227.5	17	6	0	39	3	3	0	0	0	0	0
	Vert/Flat	82.5	6	1	0	16	1	0	1	13	1	0	0	0	0	0	0
	Flat/Vert	29	2	0	0	15	1	0	0	14	1	0	0	0	0	0	0
	Flat	291.5	21	24	3	253	18	4	0	224	16	3	0	37.5	3	0	0
	Total	**1335.5**	**95**	**71**	**16**	**511.5**	**37**	**10**	**1**	**290**	**21**	**6**		**37.5**	**3**	**0**	**0**
Clear	Vertical	901	64	46	13	211.5	16	4	0	39	3	3	0	0	0	0	0
	Vert/Flat	69.5	5	0	0	16	1	0	1	0	0	0	0	0	0	0	0
	Flat/Vert	29	2	0	0	15	1	0	0	14	1	0	0	0	0	0	0
	Flat	258.5	19	20	3	211.5	16	4	0	168.5	12	2	0	37.5	3	0	0
	Total	**1258**	**90**	**66**	**16**	**454**	**34**	**8**	**1**	**221.5**	**16**	**5**	**0**	**37.5**	**3**	**0**	**0**
Not Clear	Vertical	31.5	2	0	0	16	1	2	0	0	0	0	0	0	0	0	0
	Vert/Flat	13	1	1	0	0	0	0	0	13	1	0	0	0	0	0	0
	Flat/Vert	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Flat	33	2	4	0	41.5	2	0	0	55.5	4	1	0	0	0	0	0
	Total	**77.5**	**5**	**5**	**0**	**37.5**	**3**	**2**	**68.5**	**5**	**1**	**0**	**0**	**0**	**0**	**0**	**0**

Figure 4.13 shows a redwood sample that illustrates the difference between the clear not-clear characteristic, which refers to the absence or presence of growth-related defects such as knots. Redwood had a higher percentage of clear material (94.2%) compared to 58% for the corresponding sampled survey of Douglas fir material.

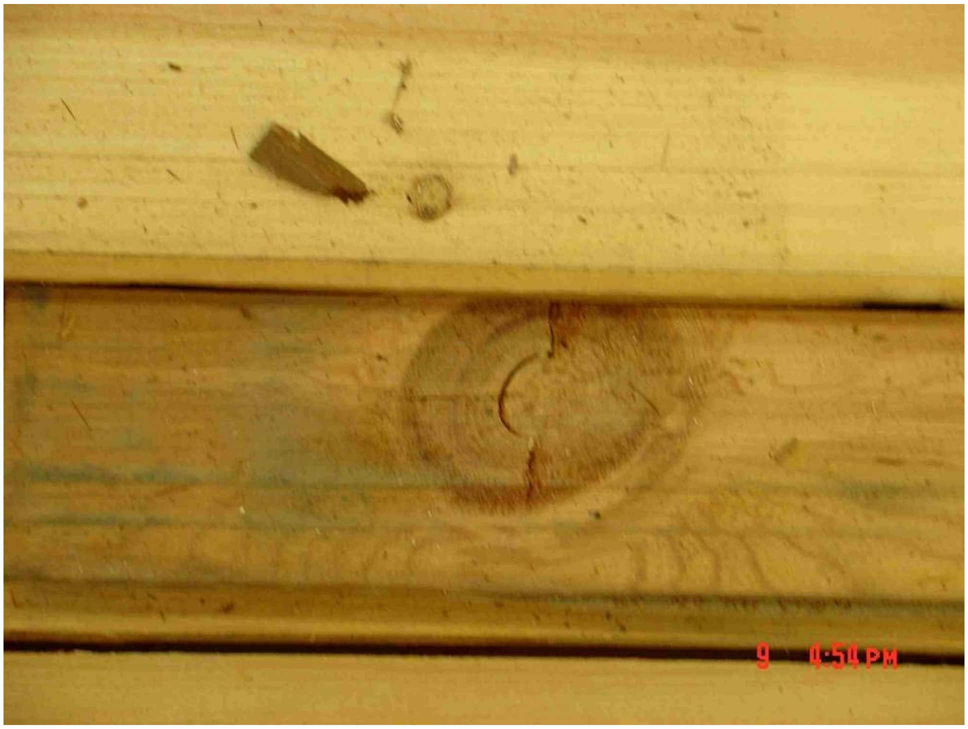

Figure 4.13. Typical size of knot and torn-out knot found in the redwood blanks. This defect was found in relatively few blanks.

The survey included 156 pieces of redwood blanks inspected, which totaled 2,175 lf of deleaded siding having an estimated end-trim loss of 87 ft (i.e., 4.0% total length). This value is almost equivalent to that observed in the inspected Douglas fir blanks (4.7%). The redwood had a slightly higher amount of vertical grain (70%) than the Douglas fir siding and floorboards combined (64%).

The presence of residual paint was observed on only 11% of the inspected redwood blanks, compared with a higher 25% occurrence in the deleaded Douglas fir blanks. The problem of residual paint affixed to the planed surfaces can be approached several different ways. One simple method would include a post-planing step using either mechanical means or an air brushing system. The owner of the Calaveritas Mill suggested that a pneumatic brushing system may prove to be the best equipment choice for addressing the problem.

4.2.6 Safety; Zero Accidents

OSHA Construction Safety Standards (29 CFR 1926); Cal-OSHA 8CCR Chapter 4, Subchapter 7, “General Safety Orders”; and Cal-OSHA 8CCR Chapter 4, Subchapter 4, “Construction Safety,” were applied to this project. AGSC developed a health and safety program (HASP) to describe hazards that would be present during the project, and measures to mitigate hazard and protect workers. Issues typically of concern on a deconstruction site include hazard communication, LBP protection, fall protection, ladder safety, personal protective equipment, equipment safety and operation, daily safety meetings, and others. As asbestos abatement was included within the contract scope, asbestos abatement and safety was included in the HASP even though it had no direct impact on the deconstruction and lead based paint removal tasks. The HASP is included in Appendix D.

Because ERDC-CERL personnel were not present at the worksite full-time, the government was represented onsite by a quality assurance (QA) representative retained by the Corps of Engineers Mobile District. The QA representative was responsible for verifying that the contractor was applying and enforcing the HASP.

Neither AGSC nor the Corps QA representative reported any accidents to ERDC-CERL. However, close examination of AGSC daily reports reveals two workers stepped on nails on different occasions, and required treatment at the Twin Cities Community Hospital in Templeton, CA. No hospitalization was required, but one worker received a two-day “no-work” order. Including treatment time, approximately 3 lost-work days occurred.

4.2.7 Safety; Airborne Asbestos and Lead

The ambient air and personal air asbestos sampling data for airborne asbestos and lead are presented in Appendix F, Tables F1 and F2, respectively. Ambient air and personal air monitoring samples were collected, logged, labeled, and transported to NAL for phase-contrast microscopy analysis. Figure 4.14 shows one of the ambient air monitoring devices used in the demonstration. Asbestos testing was performed using National Institute for Industrial and Occupational Health (NIOSH) Method 7400, and testing for airborne lead was conducted according to NIOSH Method 7082.

Air samples for asbestos testing were collected from the buildings from 16 – 25 March 2005. Concentrations of asbestos fibers found in the air samples ranged from non-detectable to 0.403 fibers/cm^3. As a point of reference, the Personal Exposure Limit (PEL) for asbestos is 1.0 fibers/cc and the Action Limit (AL) is 0.50 fiber/cc.

Air samples for airborne lead testing were taken during the deconstruction activities from 18 March – 11 April 2005. Air sample analytical results ranged from less than 6.9 – 38.1 µg/m^3. As a point of reference, the Personal Exposure Limit (PEL) for lead is 50 µg/m^3 and the Action Limit (AL) is 30 µg/m^3.

Figure 4.14. Ambient air monitoring device.

Ambient and personal air monitoring also were conducted during the reprocessing of the wood siding through the MU. Eight ambient air samples were collected both downwind and upwind of the MU, including one within the MU, on 27 April 2005. The air samples were tested by Forensic Analytical Laboratories, Hayward, CA, using NIOSH Method 7105. None of the upwind or downwind samples showed any detectable levels of lead. The sample collected from inside the MU, at the source of airborne lead particles, indicated a lead concentration of 30 $\mu g/m^3$. However, all workers entering that area wore respiratory protection. Results from the ambient air sampling for lead are provided in Table 4.6.

Table 4.6. Ambient air sampling for lead during wood reprocessing.

Sample Number	Location	Results (ug/m3)
9678B-01	Blank ND	ND (<0.2)
9678B-02	Blank ND	ND (<0.2)
9678B-03	Downwind, Origin at 20' Northwest	ND (<0.2)
9678B-04	Downwind, Origin at 20' Northeast	ND (<0.2)
9678B-05	Downwind, Origin at 35' North	ND (<0.2)
9678B-07	Upwind, Origin at 20' Southeast	ND (<0.2)
9678B-06	Downwind, Origin at 60' Northwest	ND (<0.2)
9678B-08	Upwind, Origin at 45' South	ND (<0.2)
9678B-09	Upwind, Origin at 60' Southeast	ND (<0.2)
9678B-10	Upwind, Origin at 20' Southwest	ND (<0.2)
9678B-11	At Origin, Inside Trailer Unit	30

Remarks: The sample collected inside the trailer was the only one with a detectable concentration of airborne lead.
Method: NIOSH 7105
Date Samples Collected: 27 April 2005

Air samples were collected from personnel conducting reprocessing activities on 27 April 2005. Six personal air samples were collected and transported to Forensic Analytical for testing using NIOSH Method 7082. The analytical results showed no detectable lead concentration in any of the personal monitor samples. Depending on the volume of air that passed through the filter medium, detection limits for airborne lead ranged from 5 – 20 $\mu g/m^3$. These results were below both the OSHA action level of 30 $\mu g/m^3$ and the permissible exposure limit (PEL) of 50 $\mu g/m^3$. Table 4.7 presents the results of the personal air sampling.

Table 4.7. Personal air sampling for lead during wood reprocessing.

Sample Number	Identification/Activity	Results (ug/m3)
9678B-P1	Blank	ND (<5)
9678B-P2	Blank	ND (<5)
9678B-P3	8271 / Receiving clean wood, unloader	ND (<20)
9678B-P4	4502 / Receiving, feeding painted wood	ND (<20)
9678B-P5	0753 / Receiving clean wood, sorting	ND (<20)
9678B-P6	8271 / Receiving clean wood, unloader	ND (<10)
9678B-P7	0753 / Receiving clean wood, sorting	ND (<20)
9678B-P8	4502 / Receiving, feeding painted wood	ND (<8)

Remarks: All results were less than the OSHA action level and PEL of 30 and 60, respectively.
Method: NIOSH 7082
Date Samples Collected: 27 April 2005

4.2.8 Safety; Residual Lead

ERDC-CERL collected samples of redwood and Douglas fir siding to evaluate the depth and amount of any residual lead present on the wood surface after the planing operation (Figure 4.15). Anecdotal information was previously provided to suggest that lead penetrated deeply into

the wood fibers, and that even though the paint film was removed, significant levels of lead would still be present in the material. That information came from a test conducted by Mobile District, in which a piece of painted Douglas fir siding from Fort Ord was passed through a planer multiple times, removing almost one-half of the board's thickness; a significant lead concentration was measured on the surface after planing. Camp Roberts personnel, concerned about the potential lead content of wood materials originating at Camp Roberts, would not allow a hazard to be released into the marketplace.

Figure 4.15. Siding samples awaiting lead penetration testing.

Two factors suggest that lead should not penetrate very deeply into Douglas fir. As wood is wetted with a liquid, the fibers swell, which creates a barrier to further penetration via capillary action. Old-growth Douglas fir would not be likely to absorb lead from a liquid in this manner. Judging from the description of the procedures for testing the Fort Ord siding board, ERDC-CERL personnel deduce that the board was run repeatedly through the planer, continually transferring paint residues back and forth between the blade and the freshly milled surface. If that were the case, then the apparent concentration of lead on the planed surface would have been the result of cross-contamination, not paint film penetration of the wood.

ERDC-CERL also had evaluated lead penetration of painted siding materials taken from Fort Ord buildings using a more controlled method than the Mobile District assessment. The evaluation procedure involved cleaning the planing equipment after each pass of the board through the machine. The results from that evaluation indicated that removing the paint layer and very thin layers of wood material did in fact remove all but a trace of residual lead. Similar procedures were performed on the Camp Roberts siding to confirm that residual lead would not present a hazard to subsequent users of the recovered wood.

Samples taken from Camp Roberts barracks buildings, both Douglas fir and redwood, were tested for total lead by Forensic Analytical using EPA Method 3050B/7420. Three samples each of Douglas fir and redwood siding were tested with the paint film intact, and again after shaving away 1/16, 1/8, 3/16, and 1/4 in. of wood. The equipment was cleaned after each planing pass to avoid cross-contamination.

The concentration of lead with the paint intact was 19,000 mg/kg for the Douglas fir sample and 25,000 mg/kg for the redwood. After removing the first 1/16 in. of wood, the concentration ranged from 7 – 14 mg/kg for the Douglas fir and 7 – 16 mg/kg for the redwood. The results are shown in Table 4.8.

Table 4.8. Lead penetration testing using incremental planing method.

Sample Identification	Type of Wood	Total Depth of Cut (Inches)	Analytical Results (mg/kg)	Date Analyzed
1-A'	Redwood Siding	0	25,000	18-Apr-05
1-B'	Douglas Fir Siding	0	19,000	
1-C'	Douglas Fir Interior	0	1,300	
1-A	Redwood Siding	1/16	<7	12-Apr-05
1-B	Redwood Siding	1/8	16	
1-C	Redwood Siding	3/16	17	
1-D	Redwood Siding	1/4	12	
2-A	Redwood Siding	1/16	16	12-Apr-05
2-B	Redwood Siding	1/8	8	
2-C	Redwood Siding	3/16	32	
2-D	Redwood Siding	1/4	25	
3-A	Redwood Siding	1/16	9	12-Apr-05
3-B	Redwood Siding	1/8	19	
3-C	Redwood Siding	3/16	21	
3-D	Redwood Siding	1/4	34	
4-A	Douglas Fir Siding	1/16	14	12-Apr-05
4-B	Douglas Fir Siding	1/8	10	
4-C	Douglas Fir Siding	3/16	8	
4-D	Douglas Fir Siding	1/4	8	
5-A	Douglas Fir Siding	1/16	<7	12-Apr-05
5-B	Douglas Fir Siding	1/8	10	
5-C	Douglas Fir Siding	3/16	22	
5-D	Douglas Fir Siding	1/4	14	
6-A	Douglas Fir Interior	1/16	8	12-Apr-05
6-B	Douglas Fir Interior	1/8	8	
6-C	Douglas Fir Interior	3/16	16	
6-D	Douglas Fir Interior	1/4	<6	

Method: EPA 3050B/7420

The measured lead concentrations for subsequent depths vary from less than 6 mg/kg to 34 mg/kg. This result seems counterintuitive because lead concentration would not be expected to be higher at greater depths within the wood. The reason for these results, as offered by Forensic Analytical Laboratories, is that despite efforts to prevent cross-contamination, some cross-contamination is nevertheless probable, especially considering the very low levels of lead detectable, and detected in the samples. This is not a limitation in the detection equipment, but a practical limitation in the method of cleaning the planing equipment

The lower limit of lead detection can be determined as follows. EPA Method 7420 indicates a minimum detection level of 0.1 mg/L, or 100 µg/L. EPA Method 3050B uses a 1 gram sample, and produces a final volume of 100 ml from that sample. So, from a sample prepared as above, the detection level in 100 ml would be 10 µg (100µg/L), which was digested from a 1g sample.

It is noted that the measured amounts of residual lead, even acknowledging the limitations of the testing equipment cleaning process, falls far below any toxicity factor established in human health or environmental standards. There are no federal standards that establish maximum lead content in recycled construction materials. However, the Consumer Products Safety Commission (CSPC) provides a useful and practical benchmark for assessing any hazard associated with the residual lead content. In 1978 the CSPC set the maximum acceptable lead content for consumer-grade paints to be 0.06%, which is 600 ppm, or 600 mg/kg. That value was based on a level of lead that could be ingested daily by an infant without endangering his or her health. The highest lead concentration reported in Table 4.8 is 34 mg/kg (a value that is probably an anomaly on the high end), which is approximately only 5% of the minimum acceptable level for infant exposure to lead in paint, and therefore a level that may be assumed harmless to human health in reclaimed wood building materials.

At the same time, it also must be noted that not all pieces of remilled wood were suitably free of paint residue. Of the 57 blanks inspected, 15 had residual paint that had not been completely planed off (see Figure 4.10). The presence of residual paint in these cases did not appear related to inadequate depth of wood planing, but more likely to be a result of feeding the stock too rapidly through the planing equipment.

Another common machining problem observed during remilling operations, as previously noted, was the creation of undersized blanks. See Figure 4.11 for an example of a blank almost 5/16 in. narrower than the target size width. This particular machining defect was observed in roughly 25% of the survey sample.

4.2.9 Value of Materials

After completing the inspection of the blanks, a subcontractor conducted a series of Internet searches, email contacts, and telephone inquiries to develop an estimate of the current market value or price structure for the reclaimed siding material. Few of the contacts offered an immediate or firm value estimate for this type of redwood and Douglas fir blanks because, at 0.5 in.

thick, the stock is nonstandard dimension for wood products. The sale price and marketability of a thin blanks is negatively affected because their thinness limits the types of final millwork that can be produced from them. However, redwood's durability and wide range of uses keep it in high market demand, with prices varying depending on quality and regional outlet. Consequently, the marketability of the remilled redwood materials would appear to be less negatively affected by the thin dimension than the Douglas fir stock.

Many sources contacted could only provide direct pricing information based on requested volume quotes. For example, pricing obtained from a western retail outlet for redwood quoted a current price of $1.10/lf, or $2.67/bf. That pricing (from Ponderosa Lumber Co., Scottsdale, AZ) corresponds to B&Btr appearance redwood 1 x 4 nominal size, 8 – 20 ft long. This lumber grade is mostly heartwood, limited to 5 – 10% pieces of mixed heartwood to sapwood quality. The majority of Camp Roberts deleaded blanks observed during the survey would satisfy a B&Btr grade in terms of permissible lumber defects. Using this observation as a basis for the estimate, the market value for the redwood blank material would be approximately $1.34/bf.

In addition to commercial suppliers, Mendocino Specialty Lumber Company, Arcata, CA, was contacted to provide a cost estimation for sawn 0.5 x 3 in. clear heartwood from their facilities. Mendocino (www.oldgrowth.com) specializes in old-growth redwood clear all-heart lumber, with 90% of sawmill production originating from reclaimed logs previously felled but not harvested. The mill manager indicated a selling price of $4.00/bf for heart sawn redwood, with 3 months lead time before delivery and assuming a minimum order of 1,000 bf. Mendocino operations include original 1920s millwork pattern production from 0.5 in. to 4 in. T&G flooring along with authentic period siding, trim, and wainscot. Pricing varies depending on order length, volume, and dryness.

Based on the results of Internet searches, 100% heartwood quality clear redwood is often sold at higher prices for the small-volume buyer or hobby-oriented individual. Cost per bf (Cbf) listed at www.unicornflooring.com under the category of clear redwood was identified $4.75 and $5.45 for flat-sawn and vertical grain, respectively. In comparison, clear Douglas fir Cbf was listed at $3.90 for flat-sawn and $4.60 for the vertical grain lumber. This pricing includes quantity discounts 10% with a $300 order, or 15% price reduction for purchase orders over $1,000. Discount pricing from suppliers for larger-volume purchases is also common for millwork products.

The most relevant pricing identified from the Internet searches included the 2006 price list posted by TerraMai, McCloud, CA. This company claims to specialize in reclaimed woods from around the world and sells only from 100% reclaimed and salvaging sources. In the category of domestic redwood siding and paneling, prices listed on their website range from $6.50 – $20.00/sf. Olive redwood siding ($8.50/sf) identified as all old-growth material reclaimed from 1930s-built olive curing tanks deconstructed in California. Product specifications for this particular reclaimed redwood does indicate siding may contain evidence of prior use such as brine staining, nail and/or bolt holes and oxide stains.

TerraMai quarter-inch reveal shiplap siding is surface-planed to a 5/8 x 4.5 in. and random lengths of 6 ft and longer. Reclaimed Douglas fir machined into siding and paneling versus redwood is in the lower $4.50 to $10.00 sf price range. T&G millwork in the form of unfinished 0.75 in. thick flooring, 2 – 6 in. (random length), is shown for market sale $9.50 – $12.00 sf for clear 2 – 5 in. wide Douglas fir reclaimed product. Wider (6 in. and greater) clear-grade siding is priced at a premium of $14.00 sf. Character-grade Douglas fir flooring (2 – 5 in. wide) is listed at $7.50 – $10.00. The term character-grade refers to a reclaimed product that permits minimal surface checking after millwork manufacture.

With increasing consumer recognition of redwood for exterior siding applications, even knotty grades of siding sell reasonably well. One volume distributor contacted with regional outlets, Buffalo Lumber Company (www.buffalo-lumber.com/redwood-siding), advertises a low-quality 1 x 8 T&G redwood at $1.69/lf, with minimum 2,000 or greater linear footage of siding on prepaid orders. For orders above 7,500 lf, purchases are discounted an additional $0.10/bf. This is a lower quality and more affordable redwood siding, where the millwork is sold in 6 – 20 ft lengths and contains mostly tight knots, with some loose knots permitted. In addition, a website illustration of the product shows mixed sapwood and heartwood. Telephone communication with this distributor late in 2006 indicated that prices were expected to increase within the next few months, based on the domestic supply status for redwood.

From that information it was inferred that redwood blanks not processed into millwork would likely fall into a market price range of $1.34 – $4.00. The higher prices —$4.75 (flat sawn) to $5.45 (quarter sawn) — reflect the pricing structure for small-volume purchases. Douglas fir blanks might be approximately 15 – 20% less expensive on the open market, based on advertised price information from Unicorn.

AGSC provided the processed wood blanks to Pacific Heritage Wood Supply Co. in El Granada CA. for consignment sale. That company sold 800 sf of redwood materials to LivingHomes of Santa Monica CA (www.livinghomes.net), which designs and fabricates "green" modular homes. The incorporation of reused materials is a signature feature of the company's designs. AGSC has relinquished ownership of the materials, and they are now held at Pacific Heritage Wood Supply.

4.2.10 Regulations

During the asbestos survey work, AGSC and its subcontractors complied with all applicable federal, state, and local environmental regulations on the control of air emissions and the collection, handling, and disposal of potentially hazardous wastes. Title 22, Division 4.5, Chapter 11, Article3, section 66261.24 of the California Code of Regulations characterizes the level of toxicity allowable under the law. According to the state regulations, a waste exhibits the characteristic of toxicity if representative samples of the waste have any of the following properties:

> (1) When using the Toxicity Characteristic Leaching Procedure (TCLP), Test Method 1311 in "Test Methods for Evaluating Solid Waste, Physical/Chemical

> Methods," EPA Publication SW-846, the extract from representative samples of the waste contain any listed contaminants at a concentration equal to or greater than the respective value given in that table unless the waste is excluded from classification as a solid waste or hazardous waste or is exempted from regulation pursuant to 40 CFR section 261.4. Where the waste contains less than 0.5 percent filterable solids, the waste itself, after filtering using the methodology outline in Method 1311, is considered to be the extract for the purposes of this section;
>
> (2) If it contains a substance listed in subsections (a)(2)(A) or (a)(2)(B) of this section at a concentration in milligrams per liter of waste extract, as determined using the Waste Extraction Test (WET), which equals or exceeds its listed soluble threshold limit concentration or at a concentration in milligrams per kilogram in the waste which equals or exceeds its listed total threshold limit concentration.

For the purposes of hazardous waste disposal in this demonstration, the maximum allowable concentration for TCLP analyses was 5.0 mg/L lead in the test leachate. The maximum Total Threshold Limit Concentration (TTLC) for lead is 1,000 mg/kg in the waste. Two bulk samples were taken from the LBP-contaminated wood waste and found to contain lead concentration in excess of the TCLP and TTLC limits.

In accordance with 29 CFR 1926.62(b) and Cal-OSHA 8 CCR 1532.1, staff from NAL were assigned the role of a Competent Person/Supervisor to control all hazardous work associated with lead-based paint. The Competent Person/Supervisor was certified in accordance with the California Department of Health Services (DHS), Childhood Lead Poisoning Prevention Branch, as a Project Monitor to oversee lead-related construction work and to ensure that the site activities were conducted in accordance with the work plan.

The MBUAPCB issued Permit to Operate 11374 for Portable Enclosed Wood Planing and Chipping Operation with Dust Collection Systems, Processing Wood Coated With Lead-Containing Paint, on 17 September 2004. A copy of Permit 11374 is provided in Appendix A. The permit limited operations to no more than 24,000 lf/day. The 30-day average maximum offsite air concentration could not exceed 0.30 $\mu g/m^3$. In addition, no disturbance, abrading, or grinding of asbestos-containing materials was allowed under the permit.

4.2.11 Codes

Based on the outcome of this research, ERDC-CERL anticipated contributing to the development of regulatory provisions for the sale and reuse of building materials previously coated with LBP. The penetration of lead into the wood fiber, making it potentially available to ingestion by young children in a subsequent use of the wood, was the primary public health concern. The EPA Office of Solid Waste and Emergency Response (OSWER) expressed an intent to develop guidance on handling and processing these materials, and ERDC-CERL maintained contact with that office throughout the project.

As noted in Section 4.2.8, in the absence of established standards for safe levels of residual lead in remanufactured construction lumber, it was considered reasonable to make inferences based on CPSC lead content standards for consumer-type paints. Because the residual lead levels in the remilled wood were generally found to be no more than 5% of the CPSC safe limit, there was a working agreement that the remilled wood should logically represent no significant human health hazard as distributed throughout the commercial construction materials market.

The EPA OSWER developed a draft standard for residual lead in remanufactured wood products, but in October, 2007 that office informed ERDC-CERL that it would not issue any federal guidance on the topic, and that rules established by state environmental agencies will prevail. The EPA acknowledged that Army practices for deconstructing WWII-era wood buildings, salvaging materials, and addressing environmental issues during reclamation processes are commendable. and encouraged the Army to work with state governments on deconstruction projects.

ERDC-CERL will incorporate the draft EPA guidance on lead in remanufactured construction lumber into an Army Public Works Technical Bulletin (PWTB), which is planned for release during FY08.

4.3 Data Analysis, Interpretation, and Evaluation

4.3.1 Cost Evaluation

The total cost of processing the Douglas fir and redwood siding from Camp Roberts barracks, including the contractor's additional claim, exceeded the anticipated amount by $3.49/sf of building. It must be noted that removing buildings was the fundamental Army requirement driving this demonstration, and there are many more issues to consider in a building removal project than the reclamation and reprocessing of architectural wood. In this demonstration, several factors contribute to the difference between expected and actual wood reprocessing costs.

AGSC had the required expertise in building demolition and associated tasks, but the company was inexperienced at high-efficiency building deconstruction and materials salvage. The critical metric in economically deconstructing buildings is to reduce the labor input while maximizing the productivity of deconstruction resources. AGSC's deconstruction output was approximately 8.5 sf of building per labor hour. In previous deconstruction projects, ERDC-CERL observed deconstruction rates to vary significantly. Using volunteer labor at Fort Campbell, KY, the productivity rate ranged from about 3 – 5 sf/labor hour for complete manual deconstruction; at Fort Carson, CO, the rate exceeded 12 sf/labor hour using commercial deconstruction contractors; and at Fort Lewis, WA, the rate exceeded 30 sf/labor hour with extensive use of mechanical equipment, even including underground storage tank removal and asbestos and soil abatement (Figure 4.16).

Figure 4.16. Highly efficient panelized deconstruction, disassembly, and siding removal at Fort Lewis.

Given that similar Army building deconstruction projects were completed using significantly fewer labor hours, the Camp Roberts demonstration could reasonably be expected to have been more economically successful using an experienced deconstruction crew with expert machinery support. AGSC invested a considerable amount of labor hours to remove the siding from the buildings. ERDC-CERL personnel onsite observed that the workers were very deliberate in removing and handling each siding board from the outside to avoid damaging individual pieces (see Figure 4.1). Other techniques have previously been applied to removing siding, such as pounding the boards off wall studs from the inside or cutting wall sections into panels and disassembling them on the ground. Both techniques could have reduced AGSC's labor input significantly. Because each edge of any siding board is trimmed off during milling, and split ends are chopped before reuse, a certain amount of board damage is tolerable if it significantly reduces labor input.

Waste disposal was a significant project expense, accounting for 34% of the total cost. The average cost to AGSC, for both hazardous and nonhazardous waste, was $116.78/cy, which is equivalent to $939.87/ton. Furthermore, AGSC paid $4.00/mile for hauling, which cost $495 for each 120-mile haul cycle. Reducing disposal costs would have had a significant positive impact on the economics of the project.

There were areas on Camp Roberts property where both concrete rubble and metal items were being accumulated for recycling. Had AGSC been able to make arrangements with Camp Roberts to deposit recyclable concrete and metals on-post, instead of hauling them to off-post for recycling, $17,754 in disposal costs could have been avoided for 760 cy of recyclable rubble and metal would have been avoided. Outright sale of the scrap metal would have offset project disposal costs even further.

Because AGSC was charged for tipping waste by volume instead of weight, reducing the volume of the waste would be critical to the economic success of the project. AGSC packed roll-off waste receptacles at a rate of approximately 0.12 tons/cy, or approximately 3.6 tons/30 cy receptacle. ERDC-CERL researchers observed the demolition and disposal of identical WWII wood barracks buildings at Fort Ord CA in 2003 where the contractor packed 10 –12 tons of debris into 38 cy receptacles (0.26 – 0.32 tons/cy). In other words, the Fort Ord contractor packed more than twice the weight into the same volume than AGSC. Improving the efficiency of waste loading would have reduced project waste disposal costs significantly.

ERDC-CERL anticipated that the salvaged materials would command a much higher price than they actually did. The framing lumber was sold at a low, but not unreasonable price. However, the planed Douglas fir and redwood siding remains mostly unsold, and the quantity that did sell commanded only half the price that market research had indicated it would. Several factors contributed to that result:

- The planed blank is not a finished product in and of itself, but is a feedstock that must undergo an additional process to turn it into a finished product.
- The dimensions of the planed blank produced in this demonstration are not industry-standard. This factor limits the usefulness of the blank to custom millwork, as opposed to standard, mass-production architectural millwork such as flooring.
- The volume of this product was insufficient to be commercially attractive. Calaveritas Mill is having difficulty selling the stock they have on hand. However, they have been queried by other sources about how to obtain all of the siding still in place at Camp Roberts.
- When negotiating the contract price with ERDC-CERL, AGSC would not accept the risk of selling (or not selling) the salvaged materials as an offset to their processing cost. Therefore, AGSC's cost for services was covered in the contract price, with any revenue accrued by the company being extra income above and beyond compensation for the work. That arrangement created less motivation to aggressively market the salvaged materials.

Even considering the above factors, the overall net contracted cost of deconstructing the buildings, salvaging and processing materials, and selling materials exceeded conventional demolition and disposal costs by only $0.10/sf of building, or $1,460. That small cost premium was paid in return for diverting 327 tons of debris from landfills, and there is no reason to believe that the efficiency and economic benefits of future deconstruction/reclamation projects could not be significantly improved, as discussed above.

The greatest negative economic impact on this project was an additional $47,562.50 reimbursement to AGSC for hazardous waste disposal costs that the company had not anticipated in its price proposal. AGSC processed only a portion of the 1 x 8 interior wall finish boards, and none of the painted 2 x 4 wall studs through the MU (Figure 4.17). Because the MU had been adjusted to process the 1 x 6 exterior siding boards, planing the two painted sides of the 1 x 8 interior boards would have required two passes, effectively doubling the labor requirement. The planer was capable of performing this operation, however, as AGSC and ERDC-CERL personnel processed 5,000 lf of the 1 x 8s. Processing the 2 x 4 studs would have required another readjustment of the planing device and also two passes to remove paint from all four sides of the stud. For purposes of holding down project labor expenses, the AGSC superintendent elected to dispose of those materials instead of milling them. That unilateral decision was inherently burdened by its own cost inefficiency, however, insofar as it created a significant and unanticipated load of bulky hazardous waste that had to be handled in accordance with laws and regulations. ERDC-CERL believes that AGSC's decision to dispose of the painted materials in order to reduce labor costs was not economically viable, and that it was more costly that it would have been to process the wall boards and studs through the planer.

Figure 4.17. LBP-contaminated interior wall boards (left) and exterior wall studs (right) destined for landfill.

Quantity takeoffs indicate there were 10,350 lf of 1 x 8 in. interior wall finish boards in all three buildings . Because the material was coated with LBP, it required disposal as hazardous waste,

which cost AGSC $197.20/cy. The discarded boards created approximately 80 cy of hazardous waste. Processing those boards would have reduced waste volume by approximately half (i.e., by 40 cy), and disposal cost by $7,835. Denailing would have required approximately 100 labor hours, and processing approximately 48 labor hours, which together would have cost approximately $800 more than disposal. However, AGSC also would have benefited from selling an additional 10,000 lf of blanks, which would have been worth $3,750 at the actual sale price.

Quantity takeoffs indicate there were approximately 12,000 lf of salvageable 2 x4 exterior-wall studs in all three buildings. Those were also coated with LBP, creating approximately 92 cy of hazardous waste. Processing the wall studs would have reduced the volume by approximately 90% (i.e., by 83 cy), and disposal costs by $16,350. As most of the nails would have been removed with the siding, an estimate of 100 labor hours for denailing and processing the material appears reasonable, which would have cost approximately $5,900. The processing labor itself is more than $10,000 lower than the cost of disposing of the boards as hazardous waste. Assuming a sale price of $0.11/bf for the reclaimed studs, or $1,900 in total, total cost avoidance would have been almost $12,000 when compared with outright disposal as hazardous waste.

To summarize, ERDC-CERL calculates that an investment of roughly $14,535 in processing the discarded materials through the mobile planer could have reduced the LBP hazardous waste disposal cost by approximately $24,185. That is, approximately $9,650 could have been saved had the subject materials been processed by the mobile planer unit, and that cost reduction does not consider $5,650 in potential sale price of the additional lumber that would have been reclaimed. This comparison of disposal cost versus processing cost supports the original economic assumptions made by ERDC-CERL as part of the project design.

4.3.2 Schedule Evaluation

The complete deconstruction, materials salvage, and processing cycle required approximately 8 days per building, which exceeded the intended schedule by 3 days per building. That is a significant schedule overrun for the sitework, but in the current demonstration, building removal time was not critical. There was no time pressure by subsequent property developers or construction contractors, so the demonstration schedule as executed created no adverse consequences for the Camp Roberts.

As noted above, AGCS was inexperienced in deconstructing buildings. The company's unit productivity was not unreasonably low, but there appears to be considerable room for improvement. Comparable projects with which ERDC-CERL has been involved show that deconstruction and materials recovery of WWII-era wood frame buildings can be completed in significantly less time than in the current project. For example, a deconstruction contractor at Fort Lewis WA is removing barracks from their foundations at a rate of one building per day.

Remilling the siding material was a minor component in the overall project schedule, requiring only 5 days to mobilize, set up, process the materials, and demobilize the equipment.

4.3.3 Quality Evaluation

The quality of the remilled wood materials was high(Figure 4.18). There were very few knots or other defects. Very little wood deterioration or damage was observed, meaning that little of the salvaged wood was lost to reuse.

As discussed in detail previously, some of the remilled boards emerged from the planing device with some residual LBP adhered to their surface. FPL personnel determined that the problem was caused by feeding the boards too quickly into the planer, and not by any deficiency in the planing equipment itself.

Figure 4.18. High-quality redwood before nail removal.

4.3.4 Safety Evaluation

Controlling the dissemination of airborne lead is a critical health and safety issue for a deconstruction project of this type. The Camp Roberts demonstration verifies that it is not unduly difficult to set up effective control measures in the mobile planer unit that prevent health hazards related to LBP. No significant amounts of lead, either in terms of personal exposure or ambient levels, were detected in the course of air monitoring. The only airborne lead concentration that approached the OSHA PEL was inside the self-contained MU, and worksite procedures prohibited entry by anyone without the appropriate respiration protection.

Personal and ambient airborne lead monitoring also verified that deconstruction activities do not create a safety hazard. Personal air monitoring showed airborne lead concentrations to be essentially nondetectable. Good housekeeping practices, the use of protective Tyvek suit, and frequent hand washing are judged to be effective against the transfer of lead dust on workers to offsite locations such as home.

Residual lead levels on the planed wood surfaces were verified to be benign. After the paint layer and 1/16 in. of the painted wood surface is removed the concentration of lead in the wood measured less than 30 ppm, which is far below the 600 ppm allowed for consumer-grade paint that might come into mouth contact with infants.

Overall, based on the results of this demonstration, it may be concluded that deconstruction activities should not present any hazard that is not already addressed in OSHA Construction Safety Standards. However, considering that there were two incidents in which workers stepped on nails during this demonstration, it is advisable for project managers to verify that deconstruction workers are current in their tetanus immunizations and to require that shoes with steel insoles be worn at all times on the worksite.

5. Cost Assessment

5.1 Cost Reporting

The major cost factors for this ESTCP demonstration are described in Table 5.1. These represent activities and costs directly relevant to demonstrating the mobile planing unit technology. Other costs were incurred during this demonstration (safety management, asbestos abatement, foundation removal, mobilization & demobilization, sanitary facilities, and others similar), although they would have been incurred for conventional demolition as well, and are extraneous to the demonstrated technology

Table 5.1. Costs by category (thousands of dollars).
Amounts in parentheses represent savings or cost avoidance.

Direct Environmental Activity and Process Costs				**Indirect Environmental Activity Costs**		**Other Costs**		**Total**
Startup		**Operation and Maintenance**						
MU Permitting	0.998	WWD Planer rental	1.50	PPE & Lead Containment Materials	0.13			
Siding Board Removal	73.60	MU Mobilization	0.40	Air monitoring	8.29			
Building Disassembly	15.70	Board planing	2.82					
Lumber Salvage & Resale (1)	(26.70)	Planed Wood Resale (1)	(11.9)0					
Clean Wood Recycling (2)	(16.60)	LBP residue Disposal (4)	11.30					
Siding & Board Denailing	13.60	MU Demob.	0.40					
LBP debris disposal (3)	47.86							
Totals		108.46	4.52		8.42			121.40

Notes:
(1) Includes resale value plus disposal cost avoidance
(2) Includes disposal cost avoidance
(3) Includes all debris materials except LBP residue from the MU.
(4) Includes LBP residue from the MU only.

One can see that most of the cost was attributable to removing the siding boards and preparing them planing. The actual planing operation was a relatively minor cost.

5.2 Cost Analysis

A valid cost analysis for the mobile planer application described here must proceed from the premise that the MU is only one component, albeit a central component, of an improved alternative to traditional methods for demolishing WWII-era wood Army buildings. The cost comparison must be made between the conventional wood building demolition process, on the one hand, and the demonstrated deconstruction and wood reclamation technology, on the other hand. This comparison must encompass the entire building removal methodology for each approach, not just a comparison of discarding wood demolition debris versus reclaiming the raw material and adding value to it using a specialized planing tool. The economics of using the MU in a building removal project are affected by all other aspects of the deconstruction and reclamation process. The reduction in hazardous waste generation (i.e., LBP-contaminated wood debris) and the monetary value of all recovered building materials (including non-lumber byproducts of that process such as mulch produced from wood scrap and pavement aggregate produced from concrete slabs and foundations) are two examples of building removal economics that must be assessed to develop a full and valid cost comparison.

A large portion of the cost for this demonstration involved tasks not ordinarily performed during demolition but necessary to reclaim the wood and prepare it for remilling. Removing the siding and roughly half the interior wall finish boards was the largest task in this category, costing AGSC $73,589. This work would not have been necessary in a conventional demolition project. Disassembly of the framing lumber cost AGSC $15,700, which is roughly $10,000 more than it would have cost to crush the structures with a track hoe and load the debris into a truck for disposal. Altogether, AGSC spent approximately $83,600 more to disassemble these buildings than had they mechanically demolished them.

Salvaging the clean (i.e., unpainted) lumber from the deconstructed barracks served to reduce the project landfilling requirements as compared with conventional practices. Had 33,000 bf (which is 45.4 tons, or 378 cy) of framing and sheathing lumber been disposed of as non-hazardous C&D debris, the cost would have been $23,196. Adding the $3,600 purchase price for this lumber, salvaging and selling the framing lumber saved over $26,700 compared with landfilling it. Recycling the uncontaminated wood scrap also reduced the project disposal cost compared with conventional C&D landfill disposal. AGSC paid $46 per cy less to take uncontaminated wood scrap to recycling, so the company saved $16,563 as compared with the cost of landfilling that material as C&D debris.

There are two general areas of opportunity to improve efficiency and reduce costs in a deconstruction and reclamation project similar to this demonstration:

- paint-removal milling operations
- deconstruction operations.

In this project, the MU planer was configured to remove LBP from boards up to 6 in. wide. Although the equipment owner claimed that the planer was adjustable to accommodate other board widths, this capability was not demonstrated by the work crew because the method for doing so was not self-evident. Because much of the salvaged wood was nominally 8 in. wide, there was no way to plane all the LBP off the boards without feeding it through the MU twice. In this case, 2 in. of board width were sawed (i.e., ripped) away during the first pass through the planer fed though separately. These extra steps in the planing process were given as a reason why the contractor opted to landfill most of the 8 in. salvaged boards instead of reclaiming them for marketing purposes. If the planing tool had been readily field-adjustable to handle the widest boards at the deconstruction site, milling efficiency for those boards could have increased by at least 50%, thereby removing the contractor's stated disincentive for reclaiming significant portions of the salvaged lumber.

Although the MU may be considered an enabling technology that makes it feasible to dramatically improve the economics and sustainability of building removal, successful deconstruction and reclamation work nevertheless depends on the efficient application of labor. AGSC's total building removal rate of 8.5 sf of building/labor hour has been significantly exceeded in the field by other contactors working on similar projects at other installations. For example, as noted previously, a deconstruction contractor at Fort Lewis, WA, has achieved a building removal rate of more than 30 sf of building/labor hour with expert use of mechanical equipment, a result that included the salvage of custom-grade Douglas fir siding for resale. Also, in a similar project conducted at Fort Chaffee, AR, the contractor removed the siding at a rate of more 80 sf of siding/labor hour, approximately 10 times the productivity rate (8.35 sf of siding/labor hour) achieved by AGSC. These competing productivity results show that a building removal contractor with sufficient expertise and motivation for profit could dramatically improve the economic results of a comparable project as compared with the results returned in this demonstration.

5.2.1 Cost Comparison

A direct comparison between the two processes is somewhat strained by the fact that the conventional method of building removal is driven by a much more modest objective than a deconstruction and reclamation process. Conventional demolition is intended to clear a building site at the minimum cost and within the shortest time practical; deconstruction is intended to economically reduce environmental stresses related to landfilling while extracting an economic benefit from existing materials that would otherwise be discarded. Conventional demolition does not typically take into account any environmental factors beyond regulatory compliance or any cost factors other than lowest initial cost, but the implicit purpose of deconstruction and reclamation is environmental and economic sustainability.

Owing to operational decisions made by the contractor that deviated from the intent of the demonstration (see Section 4.2.1 and Section 4.3.1), the specific outcome of this demonstration was not optimal for documenting a comparison between the alternative and conventional methods for building removal based solely on hard, accountable cost data. Consequently, the authors must

provide some interpretive cost information in order to draw a useful comparison that would pertain to a real-world deconstruction project executed with full attention to earning profits through materials reclamation and recycling.

Direct costs resulting from the use of the mobile planing unit were the cost to denail boards, the planing costs, and the cost to dispose of LBP-contaminated planing residues. Direct savings resulting from the use of the mobile planing unit were reductions in the volume of hazardous waste material requiring disposal in a RCRA-certified landfill and the resale value of planed lumber materials.

Table 5.2 compares three cost scenarios: (1) the actual demonstration costs, (2) the estimated cost of conventional demolition and landfill disposal with no consideration of cleaning and salvaging LBP-coated materials, and (3) deconstruction and salvage assuming that the contractor had planed and salvaged all the LBP-coated wood required by the project plan. Only costs directly related to the mobile planing unit technology are shown. All costs that would have been incurred irrespective of building removal method are omitted for clarity.

This demonstration also created additional economic benefits not fully attributable to the use of the mobile planing unit. These include the reduction of local landfill burdens by 327 tons and creation of sustainable construction materials that reduced demand for more than 33,000 bf of virgin lumber, over 60 tons of quarried aggregate, and over 10 tons of recycled metals. If concrete rubble and scrap metals could have been deposited with the Camp Roberts recycling programs, an additional $17,754 in hauling cost could have been avoided. That figure does not include any salvage value for the concrete or metals, or cost avoidance arising from the use of recycled concrete aggregate in place of quarried aggregate.

Table 5.2. Cost comparison (dollars) for three scenarios.
Amounts in parentheses represent savings or cost avoidance.

	Demonstration	**Conventional demolition**	**Deconstruction and salvage**
MU Mobilization	$400	$0	$400
Mobile planing unit permit	$998	$0	$998
Air monitoring	$8,300	$0	$8,300
PPE & lead containment mat'l	$125	$0	$125
Siding & board removal	$73,600	$0	$73,600
Building demolition or disassembly	$15,700	$16,500	$15,700
Lumber salvage/resale	$ (3,600)	$0	$(3,600)

	Demonstration	Conventional demolition	Deconstruction and salvage
Salvaged lumber disposal avoidance	$ (23,100)	$0	$(23,100)
Recycled wood disposal avoidance	$ (16,600)	$0	$(16,600)
Siding & board denailing	$13,600	$ $0	$13,600
WWD MU rental	$1,500	$0	$1,500
Siding & board planing	$2,824	$0	$6,500
Planed wood resale	$ (600)	$0	$ (5,200)
LBP wood disposal	$59,200	$150,000 (1)	$21,100
MU demobilization	$400	$0	$ 400
Contractor claim	$47,563	$0	$0
TOTAL	**$179,910**	**$166,500**	**$93,323**

Note:
(1) Includes all building debris. Concrete would be disposed of at a nonhazardous rate. Commingled building debris from Camp Roberts buildings exceeds the TCLP and California WET thresholds and would be disposed of at hazardous waste rates.

5.2.2 Cost Basis

There are no standard cost data or expenditures applicable to a demolition project or to building materials recovery. Based on historical contract costs for demolition projects at Camp Roberts and the former Fort Ord (both located in Monterey County), a figure of $12.00 per square foot of building was established as the cost of conventional demolition. This lump-sum unit amount includes utilities termination, asbestos abatement, building removal, foundation removal, hauling, debris disposal, site finish grading, and seeding, as is typical for building demolition contracts.

The cost basis for calculating estimated and actual costs is as follows:

- AGSC's labor requirements (i.e., labor invested task-by-task) are listed in Table 4.3.
- Labor rates were provided to ERDC-CERL by AGSC. The rates relating to the deconstruction and mobile planing unit operations were $58.83 per hour for Laborers, and $98.34 per hour for the Operator/Superintendent. These are fully burdened rates representing the total cost to the Owner, including base rate, fringe benefits, general and administrative (G&A), and other indirect costs, and AGSC's fee (ordinarily called "profit" in government contracts).
- Equipment rental rates were provided to ERDC-CERL by AGSC. The equipment applied to the deconstruction and material salvage activities were $5,962 per month for a reach forklift, 3,781 per month for a backhoe, and $2,773 per month for an end loader. Again, these are

fully burdened rates representing the total cost to the owner, including base rate, G&A and other indirect costs, and AGSC's fee.

- Disposal costs were based on AGSC's disposal invoices, manifests, and landfill tickets. An average of $197.20 per cy was paid for RCRA Hazardous Waste and $61.35 per cy was paid for nonhazardous construction debris deposited at the Waste Management Inc. disposal facility at Kettleman City CA. These lump-sum figures include hauling, tipping, mobilization and demobilization, hazard tax, King County (CA) tax, bin rental, layovers, and demurrage.
- The disposal cost for 360 cy of recyclable clean wood was reported by AGSC to be $5,523, which is a unit cost of $15.34 per cy.
- AGSC reported the sale of clean framing and sheathing lumber to be $3,600 for an estimated 33,000 bf of lumber, which is a unit price of $0.11 per bf.
- A reasonable estimated demolition cost for a wood frame building comparable to a WWII-era barracks is approximately $5,500, based on R.S. Means Building Construction Cost Data (exclusive of abatement, foundation removal, and hauling), deducting for minimum interior partitioning; and applying a location adjustment factor for San Louis Obispo, CA.

5.2.3 Cost Drivers

The primary cost drivers for this demonstration were the following:

Definition of Hazardous Waste. Disposing of LBP-coated wood is more problematic in California than the other states. In addition to the RCRA definition of hazardous (i.e., 5 mg/L soluble lead as defined by the TCLP), California also applies the Cal WET and Total Threshold Limit Concentration tests (1,000 mg/kg). The Cal WET generally results in higher concentrations because it uses a different acidic solution, a lower dilution factor, and a longer duration of extraction. Therefore, LBP-coated materials that pass the RCRA threshold for toxicity using the TCLP may fail the California definition as tested using CAL WET method. In other states, whole buildings are rarely characterized as hazardous waste because the commingled debris rarely contains more than 5 mg/L of soluble lead. Demolition debris from other WWII-era wood buildings has generally been deposited in ordinary C&D landfills and charged nonhazardous C&D debris tipping fees.

Hazardous Waste Disposal Costs. Hazardous waste disposal was a major cost component, and the economic focal point, of this demonstration. The landfills used by AGSC charged tipping fees based on volume. This fact is central to project economics because non-compacted LBP-contaminated wood shavings collected from the MU occupy a large volume at low weight. Furthermore, commingled building debris such as mixed sizes of waste lumber create voids when randomly tossed into a receptacle, making inefficient use of the volume in the dumpster. Compacting the shavings and carefully stacking pieces of lumber waste could have reduced the volumes of these materials considerably. At other landfills, tipping fees may be based on weight, and that fee structure would greatly reduce the user's economic need to carefully pack bulk waste containers. However, in either case there is an economic incentive to pack the dumpsters more densely to reduce the number of hauling cycles between worksite and landfill. Also, because

hauling costs contribute to waste disposal costs, especially with rising fuel costs, reducing both the number of hauling cycles and distance to the landfill would lower project waste disposal costs.

Labor Effort to Remove and Prepare Materials for Processing. The single largest cost component of this project was siding removal. This task was executed by the contractor in a very deliberate fashion, leading to a low rate of productivity. Because siding removal was performed exclusively with manual labor, every labor hour spent on the task created additional expense. Other, more efficient methods have been applied by the building deconstruction community to remove sheathing, siding, and flooring from framed walls and floors. Increasing the productivity of siding removal will dramatically reduce the overall cost of deconstruction and wood reclamation.

Contracting for Services. The contract under which AGSC worked (or any other contractor will work) affects project performance and the end result the government realizes for its expenditure. The ERDC-CERL demonstration contract with AGSC was not intrinsically a construction-type contract, but the statement of work was developed to incorporate the tasks, responsibilities, and risks ordinarily present in a conventional construction services contract. In terms of the specific contract for this ESTCP demonstration, two issues are worth noting:

1. It would have been unreasonable to require the contractor to salvage every piece of painted lumber from these wooden buildings.
2. It would have been unreasonable to require AGSC to assume the full risk of selling the reclaimed wood as a contract requirement given the uncertainty of the emerging market for such materials.

In consideration of those two constraints, AGSC was allowed to salvage, recycle, or dispose of the deconstructed building materials at the company's discretion. Ownership of the salvaged and planed materials was granted to AGSC, but the negotiated contract price was intended to cover all the contractor's expenses irrespective of whether the salvaged materials were sold. AGSC personnel had visited Camp Roberts to closely examine the subject buildings and gave every indication of understanding the objectives and economics of the demonstration. ERDC-CERL made a reasonable assumption that the contractor fully understood the project requirements and based its price proposal on a project plan that would ensure the level of profit incorporated into the contract. As discussed in Section 4.3.1, however, AGSC elected to dispose of interior wall finish materials and exterior wall studs instead of reprocessing them, perhaps not fully considering the implications of that decision for its contractual hazardous waste disposal obligation. That decision by the contractor added approximately 17 tons of lead-contaminated materials to the project's hazardous waste stream, creating a large unanticipated expense for AGSC. Ultimately, the government elected to grant AGSC's request for additional reimbursement to cover that unplanned hazardous waste disposal cost.

ERDC-CERL believes that AGSC's decision to increase its own hazardous waste disposal burden in order to reduce labor costs would not be repeated by any prospective contractor with an established deconstruction/reclamation business model for building removal.

Recovered Material Value. Contrary to ERDC-CERL expectations, relatively little of the remilled wood materials sold. Most of the material is still in storage at Pacific Heritage Wood Supply Co. AGSC has relinquished ownership of the wood to the government, and at the time of this writing, ERDC-CERL and Pacific Heritage were negotiating an agreement by which Pacific Heritage can more aggressively market the wood and truly assess its value and applications. The company anticipates a considerably higher selling price than the $0.75/sf they received from their previous sale.

5.2.4 Life-Cycle Costs

In the case of Camp Roberts, the Army does not incur landfill life-cycle costs directly because it pays for disposal of debris off-post. Ideally, the off-post waste disposal facility funds its landfill operation, management, monitoring, closure, and long-term monitoring out of its tipping fees. If, however, an installation owns and operates its own landfill, as do most major troop installations, then the Army directly bears the life-cycle cost of landfilling C&D waste.

Based on a survey of three installations, the Army life-cycle cost of landfill management is $38 – $50/ton (net present value). Every ton of C&D debris not deposited in a landfill can be inferred to reduce Army waste management costs by an amount falling within that range. Furthermore, because landfill expansion on installations is no longer permitted, existing on-post landfill capacity is a resource that cannot be replaced.

The total amount of materials diverted from landfills by this demonstration was 327 tons. If Camp Roberts operated its own landfill, then using a conservative life-cycle cost of $38/ton, an equivalent life cycle savings would amount to $12,426 (net present value) for this demonstration.

Life-cycle expenses encompass more than the direct cost of landfill management. Other life-cycle environmental stressors are produced by C&D waste, although the adverse effects have not yet been quantified in financially. The EPA Waste Reduction Model (WARM) analyzes the life-cycle effects of alternative waste disposal scenarios. The output is quantified in terms of metric tons of carbon equivalent (MTCE), metric tons of carbon dioxide equivalent ($MTCO_2E$), and energy use in millions of BTUs. Two scenarios were run to identify both the life-cycle environmental effects of landfilling all building debris and diverting materials from landfills (as recorded for this demonstration). Table 5.3 shows the baseline scenario (landfill disposal of all materials), and an alternative disposal strategy (source reduction through reuse, recycling, and disposal).

Table 5.3. WARM results for demonstration waste diversion.

Baseline Scenario: Landfill all C&D Debris					
Material	*Generated*	*Recycled*	*Landfilled*	*Combusted*	*Composted*
Concrete	190 tons	0 tons	190 tons	0 tons	0 tons
Lumber	98 tons	0 tons	98 tons	0 tons	0 tons
Metals	3 tons	0 tons	3 tons	0 tons	0 tons
Alternative Scenario: ESTCP Demonstration Waste Diversion					
Material	*Generated*	*Recycled*	*Landfilled*	*Combusted*	*Composted*
Concrete	190 tons	190 tons	0 tons	0 tons	0 tons
Lumber	45 tons	27 tons	26 tons	0 tons	0 tons
Metals	3 tons	3 tons	0 tons	0 tons	0 tons

Reducing the quantities of waste generated through salvage for reuse and recycling, WARM calculated the life-cycle effects of this demonstration would be as follows:

- Reduction of 81 MTCE
- Reduction of 149 $MTCO_2E$
- Reduction of 546 MBTU energy use, which is equivalent to 94 barrels of oil, 4,367 gallons of gasoline, or removing 8 passenger cars from the roadway every year.

6. Implementation Issues

6.1 Environmental Checklist

Air emissions were the most sensitive environmental issue associated with operation of the mobile planer technology. In a 2004 project involving the MU in Monterey County, CA, both airborne lead and diesel exhaust emissions were monitored, and the results were submitted to the Monterey Bay Unified Air Pollution Control District (MBUAPCD). The MBUAPCD issued a permit to operate the MU for that project.

The prevailing air quality regulation at the demonstration site, and throughout California, is Article 1, Chapter 3, Part 4, Division 26 of the Health and Safety Code of the State of California. Work outside of California will fall under the state and local air quality or emissions regulations applicable to the project site.

Lead hazard was also an important environmental issue relative both to waste disposal and occupational safety. However, lead safety requirements are well known within the construction industry, and safety practices are routine. At the demonstration site, Title 22, Division 4.5, Chapter 11, Article3, section 66261.24 of the California Code of Regulations applies to characterize the allowable level of toxicity. This regulation establishes thresholds for toxicity of various materials and substances, and therefore defines what must be disposed of as hazardous waste. At the federal level, toxicity in waste is regulated by RCRA, which is part of 42 U.S.C. §§6901–6992k. Occupational safety with regard to lead exposure of workers is regulated by 29 CFR 1926.62(b), Construction Safety Standards, Part 62 Lead in Construction, and Cal-OSHA 8 CCR 1532.1, Cal-OSHA Construction Industry Lead Standard.

Other relevant environmental and health issues, such as asbestos abatement, are not directly related to operating the mobile planer unit but are regulated as standard practice within the construction industry. Therefore, those issues are not discussed here; environmental protection construction specifications articulate these requirements. One example used by federal agencies is Unified Facilities Guide Specifications (UFGS) 01 57 20.00 10, Environmental Protection.

6.2 Other Regulatory Issues

Note that there is no federal regulation or standard that either controls or prohibits salvaging or reusing LBP-coated building materials. While RCRA defines hazardous concentrations of lead in a waste context, reusing building materials with LBP does not fall under RCRA because the materials are not part of a waste stream. Regulators are frequently undecided or ambiguous in their opinions on reusing LBP-coated materials.

It is unclear which, if any, regulatory guidance governs the handling and reuse of LBP-coated lumber recovered from an existing building. Uncertainties include

- whether it is permissible to reuse a member while still painted and, if it is, what precautions must be taken
- whether the paint must be removed before reuse and, if so, what lead residual levels are permissible in on lumber after the coating is removed
- how to handle and dispose of the waste wood shavings and paint
- whether the lumber, either painted or unpainted, can be transferred from one party to another, and if so, what information or disclosures must be included in the transfer
- which household exemptions, if any, may apply to a salvage and reuse scenario.

Regulations are in place governing LBP in housing where children most vulnerable to the hazards of lead are present (i.e., children under 6 years old). In the regulations, this housing stock is referred to as *target housing* and *residential dwelling or child-occupied facility*. These regulations apply to a very narrow definition of environments. In the context of target housing, LBP hazard is defined as a condition where paint dust is generated by friction or impact, and deteriorated paint that is detached from the surface and available for ingestion by children. LBP is defined as not being a hazard if it is in good condition and not subject to friction or impact. The pertinent documents are as follows:

- 40 CFR PART 745.61; IDENTIFICATION OF DANGEROUS LEVELS OF LEAD; FINAL RULE: In this regulation, the EPA defines "lead-based paint hazard" as (1) any LBP on a friction surface subject to abrasion where dust levels are greater than defined in this Rule, (2) damaged or deteriorated paint on an impact surface, (3) any chewable LBP where there is evidence of teeth marks, or (4) any other deteriorated paint on the interior or exterior of a residential dwelling or child-occupied facility. This document defines deteriorated paint as "any interior or exterior paint or other coating that is peeling, chipping, chalking, or cracking, or any paint or coating located on an interior or exterior surface or fixture that is otherwise damaged or separated from the substrate."
- EPA FACT SHEET; IDENTIFYING LEAD HAZARDS IN RESIDENTIAL PROPERTIES: This document describes the same conditions that define LBP a hazard in 40 CFR 745.61. It also states that LBP "is usually not a hazard if the paint is in good condition and is not on an impact or friction surface (like a window, door, or stair)."

When a residential structure constructed before 1978 is sold or leased, the potential for the presence of LBP must be disclosed to the buyer or renter. If LBP testing has been conducted, the results must also be disclosed. This rule does not require testing or mitigation of LBP, only that the buyer or renter acknowledges the receipt of this disclosure and is given an opportunity to perform their own inspection before committing to the sale or lease. The required language for this disclosure includes reference to an EPA pamphlet entitled "Protect Your Family from Lead in Your Home." The applicable documents are as follows:

- HUD 24 CFR PART 35, EPA 40 CFR PART 745 LEAD; REQUIREMENTS FOR DISCLOSURE OF KNOWN LEAD-BASED PAINT AND/OR LEAD-BASED PAINT HAZARDS IN HOUSING; FINAL RULE. This document describes requirements for dis-

closing LBP when selling or leasing target housing. A definition of “lead-based paint hazard” is consistent with those given in the documents cited above. To paraphrase the language, the seller or lessor must disclose to the purchaser or lesee the presence of any known LBP and LBP hazard; provide available records and reports, provide the purchaser or lesee with a lead hazard information pamphlet (see below), give the purchaser an opportunity to conduct a risk assessment or inspection, and attach specific disclosure and warning language to the sale or lease contract. Buyers or lessors must then acknowledge that they have received the information and have had the opportunity to perform an inspection. This document provides the specific disclosure language, sample contract provisions, and reference to the EPA pamphlet “Protect Your Family From Lead in Your Home.”

- EPA/HUD/CPSC PAMPHLET, PROTECT YOUR FAMILY FROM LEAD IN YOUR HOME: This document is referenced as the required lead hazard information pamphlet per the disclosure regulation summarized above. It describes the harmful effects of lead in the human body, conditions that constitute lead hazard, and precautionary measures. The description of lead hazard is consistent with the conditions described previously in the regulation. This pamphlet also states that "Lead based paint is usually not a hazard if it is in good condition and is not on an impact or friction surface like a window."

The Consumer Products Safety Commission has established a limit on the lead content in consumer paints to 0.06% by weight (industrial and other specialty paints are exempted), and applies this limit to the lead content of paint on toys, furniture, and other household articles to which children may be exposed. This limit was established to correspond to the maximum allowable amount of lead a child can ingest per day without developing serious health problems (15 μg). While lead can be a hazard to adults also, it is clear that the intent of the lead content limitations is to protect children from health hazards associated with ingesting lead during the primary growth years. These precautions should apply to any environments in which children are present even though that is not explicitly stated in the regulations. What is not clear is how, if at all, these regulations apply to salvaging materials from one structure, reusing them in another, and the activities that may take place in between salvage and end use.

- 16 CFR PART 1500.230 CONSUMER PRODUCTS SAFETY COMMISSION GUIDANCE; GUIDANCE FOR LEAD (Pb) IN CONSUMER PRODUCTS: Note that this is <u>guidance</u>, not a <u>Rule</u>. It offers the following: Household products that expose children to hazardous quantities of lead under reasonably forseeable conditions of handling or use are "hazardous substances." A toy or other item intended for use by children containing a hazardous amount of lead accessible for children to ingest is banned. A household product that is not intended for children but which may create a risk of injury because it contains lead requires precautionary labeling under 15 U.S.C. 1261 (p). CPSC bans paint and other surface coatings on toys and other articles intended for use by children with lead concentration of over 0.06%.

Although the CPSC limit for lead in paint does not directly apply to the wood recovery process demonstrated in this project, using that value as a benchmark for acceptable levels of lead on material surfaces is useful in assessing whether any hazard is present after the LBP is planed from

the wood. Table 4.8 shows that residual levels of lead on the planed materials are well below the 600 ppm acceptable for household paint.

ERDC-CERL and industry stakeholders had anticipated that the EPA Office of Solid Waste and Emergency Response (OSWER) would issue guidance to clarify the appropriate handling, processing, and use of salvaged building materials containing LBP. ERDC-CERL personnel provided input and monitored EPA's progress on this guidance. The EPA OSWER developed draft guidance for salvaging, handling, processing, and applying LBP-containing materials or materials from which LBP was removed. Ultimately, that office elected to defer to state environmental agencies for policy and regulation, so the Corps or Army installations will have to consult state regulators. ERDC-CERL is developing a Public Works Technical Bulletin on the topic on behalf of Headquarters, U.S. Army Corps of Engineers. The document is intended to be applicable to Army projects and to any Department of Defense, Federal, or construction industry requirements.

6.3 End User Issues

Standard practice for the removal of WWII-era wood buildings on Army properties is to contract for demolition services. The contract may be initiated by an installation's Directorate of Public Works (DPW) or Public Works Business Center (PWBC), or by a Corps of Engineers activity such as a District or Support Center. The contract may include demolition services only, which is more typical of a DPW or PWBC activity; or may include demolition as one item within a construction project, which is more typical of a district. Rarely would the Army perform demolition services with in-house resources.

ACSIM (DAIM-FD) Policy Memorandum (06 February 2006, revised 11 July 2006) requires a minimum of 50% (by weight) diversion of nonhazardous waste from landfills. Note that in all states except California, buildings with LBP-coated materials would not necessarily be characterized as hazardous in a conventional demolition scenario, and would therefore would fall under the ACSIM requirement. If the concentration of lead in exterior paint is high enough, the exterior siding itself may be characterized as hazardous.

6.3.1 Stakeholders

In deconstruction projects similar to this demonstration, the user of the mobile planing technology will not typically be the Army, but the contractor selected to remove the buildings for the Army. As a stakeholder, the Army will benefit from the waste diversion performance because diversion is required by the Department of Defense Measure of Merit and the ACSIM Policy on C&D debris management.

Where an installation operates a C&D landfill on-post, the installation's solid waste management authority (typically within the DPW/PWBC Environmental Division) will be the primary stakeholder in C&D waste reduction. Because opening new landfill cells or expanding existing ones is

no longer be permitted, decreasing landfill disposal volumes will reduce the consumption rate of available capacity and prolong the service life of the landfill.

Where the installation does not operate a C&D landfill on-post and debris is hauled to a landfill off-post, the primary stakeholder in C&D waste reduction will be local or regional solid waste management authorities, specifically the recycling and waste reduction agencies. Although installations are obligated only to comply with the prevailing solid waste, air, and water emissions regulations, any performance that exceeds minimum compliance standards would be expected to be recognized and supported by the local jurisdictions.

6.3.2 End User Concerns and Decision Factors

In order to make the best use of mobile planing technology, two conditions must be present in the building removal requirements: (1) LBP-coated wood must be present, as is typical in WWII-era wood buildings, and (2) the species and grade of the painted wood must be valuable enough to have an established or potential market demand. A third condition is relevant to the economic feasibility of a project using this technology: the cost of disposing of LBP-contaminated materials is significantly higher than disposing of common C&D debris. An installation must know whether all three conditions apply before considering wood reclamation as a requirement or an opportunity in their building removal practices.

Standard practice is that title to debris materials is vested to the contractor. The primary purpose of this provision is to place responsibility for proper disposal of all materials with the contractor. However, this provision also empowers the contractor to extract valuable materials for recycling or reuse. Selling metal scrap for recycling is an attractive incentive for demolition contractors, and common practice within the industry. Title to the debris materials provides an opportunity for the contractor to salvage materials, reduce costs, and compete more effectively for Army building removal projects by bidding a lower price for their services. Decisions about what to salvage and methods for doing so will be the contractor's. While debris diversion criteria must be included in project contract requirements, the means, methods, techniques, procedures, and sequences to achieve these requirements are not for the contracting agency to decide. The Army should not direct a demolition or deconstruction contractor to use a particular technology, but should develop demolition or deconstruction contract requirements that allow the contractor to economically use the mobile planer technology, if they choose, and remove any inadvertent obstacles that standard contracting practices may impose.

6.3.3 Technology Maturity and Availability

The WWD MU used in this project was fully functional and operated as expected, but it was basically a working prototype. It is too early to project the future market demand for such a device.

Although the MU functioned effectively, a few minor difficulties were encountered. The operators did not empty shavings from the debris-collection bags frequently enough, which caused the

shavings to back up and clog the planing mechanisms. More attention to that activity should eliminate the problem. Alternately, the collection system could be modified to provide greater storage capacity.

No elevated levels of airborne lead were detected, but the outlet for the planed boards did allow some wood fibers to escape the MU enclosure. A revised exit curtain detail and better management of the shaving collection system should resolve the problem.

Because only one MU of this type exists at present, it seems improbable it could be used for a significant portion of the Army's WWII-era building-removal requirements. As of December 2007, the owner of the MU was retired from the building materials recovery industry in California, and no plans had been made to further develop or replicate the unit. The machinery was last used at the former Fort Chaffee, AR[8].

While the WWD MU is not readily available for wood reclamation at this time, other mechanical paint removal processes for the purpose. ERDC-CERL and the USDA FPL processed Douglas fir siding from Fort Ord using a Diehl Model D-6 four-head molder to remove the cove (the concave recess on the siding board). Trial lots of T&G flooring, V-groove siding, and bevel siding were produced. The equipment used to produce those profiles was commercially available woodworking shop equipment with a HEPA filter evacuation system installed to collect the lead-contaminated residue[9].

Two projects in which LBP was removed from higher-value wood materials using conventional woodworking equipment took place in 2006 at Fort Lewis, WA (FY06 MCA PN 25057, "Battle Simulation Barracks Demolition"; and FY06 MCA PN 50381, "41st Division Barracks Demolition") A deconstruction contractor removed Douglas fir T&G siding from two barracks and sold it to a local mill. The mill removed the LBP but did not reshape the boards. That cleaned wood was then resold for incorporation into the adaptive reuse of a historic building in a Seattle-area community.

6.3.4 Procurement

Standard contracting practices can be used in Army deconstruction (i.e., building removal) projects. However, some adjustments in practice can be made to ensure that debris reduction requirements are met and to attract participation by contractors who are qualified and well versed in the techniques and procedures of deconstruction and materials reclamation. Such adjustments would include performing appropriate outreach to attract contractors with the necessary exper-

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[8] In January 2008, while being used in a private venture for materials recovery, the mobile unit was destroyed by a wind-driven fire that burned down 150 barracks at the former Army installation.

[9] Falk et al. 2005.

tise; distributing information on building construction, types and quantities of materials available for reclamation, and the potential for recovery and reuse; facilitating information exchange among demolition contractors and other salvage and material recovery and reuse services; allowing sufficient time for deconstruction and processing reclaimed materials; facilitating arrangements for air emissions permits with local authorities if necessary; and vesting title to the materials with the contractor. Although it would be impractical to require use of the WWD mobile planer unit, the procurement process and contract provisions should be developed so nothing prevents its use.

6.3.5 Lessons Learned

6.3.5.1 Marketing Lessons

Due to the lack of industry-wide inventory and marketing data for reclaimed wood products, it is currently difficult to project the economic value of such material to its owner. The quality of wood originally used in the subject barracks was good. A greater percentage of redwood was available in the reclaimed stock of wood than first estimated, and it appears to have high value and good commercial potential. Eight-hundred square feet of reclaimed redwood reclaimed was used in the design and construction of a "green" modular home.

The thickness of the blank stock produced by the MU, 5/8 in., must be considered a limitation of the technology because it is not an industry-standard millwork thickness. Wood reclaimed through this deconstruction/reclamation process cannot be used for any standard millwork profile that exceeds a thickness of 5/8 in. This limitation could restrict the scope of market development for reclaimed wood products remilled from deconstructed wood military buildings, but it does not pose a critical obstacle to profitable large-scale adoption of the technology by motivated entrepreneurs with applicable technical and marketing expertise.

Army building removal projects using the methodology described here should not overlook the positive economic and sustainability impacts of recycling the other valuable raw materials that are available for reclamation in a deconstruction project. The efficient reclamation and recycling of steel, copper, and concrete could significantly help to offset project costs or provide additional revenue streams for the installation or building removal contractor.

6.3.5.2 Technical Lessons

The utility of mobile planing technology would significantly improve if it were field-adjustable to handle a wider variety of feedstock widths. The MU worked well and efficiently on the salvaged 6 in. by 1 in. (nominal) siding boards in part because the cutting blades and heads were configured compatibly for feedstock of those dimensions. However, because the blades and heads were not readily adjustable to remove paint from the entire surface of wider stock in one pass, the 8 in. boards required two planing operations combined with a sawing operation (see Section 5.2, "Cost Analysis"). This modified procedure significantly reduced the efficiency of

milling those boards, thus prompting the contractor to incorrectly assume it would be more economical to dispose of the wider LBP-contaminated boards. For the best results in terms of economics and sustainability, Army users of this technology should favor planing devices that are field-adjustable to accommodate all of the standard stock sizes likely to be found in WWII-era temporary wood construction.

The visible LBP traces found on many processed boards (see Figure 4.10) were determined attributable to feeding some of the wood into the planer too rapidly, causing minor recontamination of the planed wood from residues adhering to the outer edge of the cutter blades. This cross-contamination problem is not inherent to wood planing technology, however, and is avoidable through appropriate operator training and experience with the device.

6.3.5.3 Partnering and Contracting Lessons

The MU is an innovative tool that makes it feasible to safely and efficiently reclaim seasoned wood previously coated with LBP. However, the tool itself is part of an integrated building removal technology that presupposes the application of safe and cost-effective deconstruction and materials reclamation techniques. In order to achieve the goals of sustainability and economy, the customer and the contractor must share a clear understanding of the building removal objectives and develop a well coordinated work plan.

In future sustainable building removal projects, the Army contracting activity should solicit for motivated bidders with experience and capabilities in the areas of building deconstruction, materials reclamation, and working with specialty millwork markets. In this demonstration, the contractor did not provide the expected level of economic performance in its actual deconstruction, salvage, and paint-removal field operations even though the firm was highly qualified to perform conventional construction and demolition work. The profitability of a deconstruction and reclamation project depends in significant part on the contractor's expertise in building disassembly, reclamation and waste handling judgment, and efficient remilling workflows. The scope of work should include explicit language about the Army's building removal, waste management, and project sustainability requirements, but should avoid language that inhibits a qualified contractor's independent judgments about reclaimed materials of marginal economic value.

In addition to the partnering issues discussed above, a project management lesson related to contracting for this specific demonstration provides some necessary context for understanding the cost and performance results reported here. Although it may have been justifiable to use a research-type contract for the execution of this demonstration, the authors chose to use a contract modeled on a construction services scope of work. The reason for this decision was to provide a more realistic project environment for work execution: the services contract used here reflected the requirements of a real-world project, as opposed to a highly controlled and closely supervised conditions that prevail in a research-type contract. Project realism was considered important because the subject deconstruction and reclamation technology is intended for use within the mainstream construction services industry, and it was felt that rigorous government control of the con-

tractor's activities might give the appearance of significantly higher productivity than actually warranted by the conditions in a real-world project. Therefore, the scope of work assigned to the contractor the responsibility to "determine the types of wood products produced from the reclamation process and the outlets to which they are sold based on their own market analysis."

In this demonstration, however, the government and the contractor interpreted other important passages of the contract language and intent differently, and the result was less materials reclamation and more hazardous waste disposal than ERDC-CERL expected. Specifically, two key performance requirements for the contractor were to "[m]aximize the yield of [reclamation] processes by utilizing all available wood dimensions and shapes to the greatest extent practical" and to "[r]ecycle clean wood materials that have no potential for re-manufacturing and reuse." These requirements were discussed and understood during the contract negotiation and award process, and during project planning meetings, but they were not rigorously adhered to by the selected contractor. The resulting productivity results were significantly lower than what may reasonably be anticipated assuming the award goes to a building removal company with sufficient expertise and self-motivation. The lesson learned with regard to designing a technology demonstration of this type is that it would have been advisable to include an explicit contract requirement to process a definitive quantity of LBP-coated lumber of each dimensional type, and to require the market analysis to explicitly describe what materials would and would not be sellable in the marketplace.

7. References

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ISO 14001:2004(E) International Organization for Standardization (ISO). 1996. Environmental management systems – Specification with guidance for use. Geneva Switzerland: International Organization for Standardization.

Unified Facilities Guide Specification (UFGS) 01451A. January 2003. Contractor quality control. Washington DC: National Institute for Building Sciences.

8. Points of Contact

The lead organization was the U.S. Army Engineer Research and Development Center, Construction Engineering Research Laboratories (ERDC-CERL) located in Champaign, IL. ERDC-CERL coordinated the demonstration at the Camp Roberts California Army National Guard installation in west-central California. Auburn Machinery provided the equipment and technical expertise in the processing of LBP-coated wood. In coordination with Auburn Machinery, Wood Waste Diversion performed the building deconstruction to provide the process feed materials. The Forest Products Laboratory and Auburn Machinery evaluated the conversion into value-added products and to develop markets for these environmentally friendly products. All parties worked together to ensure that the demonstrations met the needs of DoD and the private sector, and assisted in technology transfer activities, including to wood manufacturing companies, engineering and construction companies, and state agencies exploring wood recovery operations in deconstruction projects.

Points of Contact.

Name	Organizational Affiliation and Address	Phone/Fax/Email	Role
Mr. Richard G. Lampo	U.S. Army Corps of Engineers Construction Engineering Research Laboratory Attn: CEERD-CF-M PO Box 9005 Champaign, IL 61826-9005	217-373-6765 (fax) 217-373-6732 r-lampo@cecer.army.mil	Project Manager Research Materials Engineer
Mr. Tom Napier	U.S. Army Corps of Engineers Construction Engineering Research Laboratory Attn: CEERD-CF-F PO Box 9005 Champaign, IL 61826-9005	217-373-3497 (fax) 217-373-7222 t-napier@cecer.army.mil	Co-Project Manager Research Architect
Mr. Steve Cosper	U.S. Army Corps of Engineers Construction Engineering Research Laboratory Attn: CEERD-CN-E PO Box 9005 Champaign, IL 61826-9005	217-352-6511, ext.5569 (fax) 217-373-7222 s-cosper@cecer.army.mil	Research Environmental Engineer
Mr. David T. McKay	U.S. Army Corps of Engineers Construction Engineering Research Laboratory CEERD-CF-F PO Box 9005 Champaign, IL 61826-9005	217-373-3495 (fax) 217-373-7222 d-mckay@cecer.army.mil	Research Civil Engineer

Name	Organizational Affiliation and Address	Phone/Fax/Email	Role
Mr. Stanley Eller	USA Recovered Resources 308 Fountain Ave Pacific Grove, CA 93950 Auburn Machinery, Inc. (AMI) 150 Summer Street Lewiston, ME 04240	207-623-0359 (fax) 207-623-0359 seller1@adelphia.net	Principal USARR Senior Project Administrator Principle, AMI
Dr. Robert Falk	Forest Products Laboratory (FPL) One Gifford Pin.ot Drive Madison, WI 55705	608-231-9255 (fax) 608-231-9303	Data QA/QC
Mr. John Stevens	USA Recovered Resources 308 Fountain Ave Pacific Grove, CA 93950 Wood Waste Diversion / The Paramount Group 234 Mar Vista Drive Monterey, CA 93940	TEL: (831) 809-2627 FAX: (831) 643-2112 JBsfortOrd@aol.com	Principal USARR, Camp Roberts Site Superintendent Owner Wood Waste Diversion
Mr. Bradley Guy	University of Florida Center for Construction and Environment College of Design, Construction and Planning 101 FAC PO Box 115703 Gainesville, FL 32611-5703	minou@grove.ufl	Verify collected data and assess recovery rates
Mr. Tommy Lightcap	U.S. Army Corps of Engineers, Mobile District Attn:CESAM-PM-SI Post Office Box 2288 Mobile, Alabama 36628-0001	251/694-3600 Thomas.A.Lightcap@sam.usace.army.mil	Onsite USACE Representative, Quality Control, Quality Assurance Officer
MSGT Walter Whitestine	Headquarters, Camp Roberts ATTN: CACR-DIS Camp Roberts, CA 93451-5000.	805/238-8571 walter.whitestine@ca.ngb.army.mil,	Camp Roberts POC
Patti Harris	USA Recovered Resources 308 Fountain Ave Pacific Grove, CA 93950	831-884-9709 PWeir3030@aol.com	Admin for USARR

Appendix A: Permit to Operate 11374, for Portable Enclosed Wood Planing and Chipping Operation with Dust Collection Systems

MONTEREY BAY
Unified Air Pollution Control District
serving Monterey, San Benito, and Santa Cruz counties

AIR POLLUTION CONTROL OFFICER
Douglas Quetin

24580 Silver Cloud Court • Monterey, California 93940 • 831/647-9411 • FAX 831/647-8501

SEP 17 2004

John Stevens
Wood Waste Diversion, Inc.
308 Fountain Avenue
Pacific Grove, CA 93950

Subject: PERMIT TO OPERATE 11374
PORTABLE ENCLOSED WOOD PLANING & CHIPPING OPERATION WITH DUST COLLECTION SYSTEMS, PROCESSING WOOD COATED WITH LEAD-CONTAINING PAINT

Dear Mr. Stevens:

The District has completed its evaluation of the following portable operation:

- processing wood coated with lead-containing paint through an enclosed wood planing and chipping trailer equipped with dust collection systems.

The District has determined that the equipment, with operating restrictions, has the capability to comply with all applicable District rules and regulations.

Accordingly, I have enclosed Permit to Operate (PTO) 11374 authorizing the operation of the portable enclosed planing & chipping operation, equipped with dust collection systems. This permit must be posted or kept readily available at the operating premises.

Please review the permit and note the conditions which have been included on it. These conditions are necessary to ensure that the equipment will operate in accordance with all applicable District regulations. In particular please review Conditions 2, 3, 4 and 9 as follows:

2. Wood Waste Diversion, Inc. shall maintain a daily log which includes diesel fuel usage, linear feet of wood processed, and the volume of wood waste collected.

3. No more than 24,000 linear feet per day of wood coated with lead-containing paint shall be processed through this equipment.

4. The 30-day average maximum off-site air concentration shall not exceed 0.30 $\mu g/m^3$ of organic lead.

9. No disturbance, abrading or grinding, of asbestos-containing materials shall occur from this operation.

Please note that the State of California has identified particulate emissions from diesel engines as a cancer causing pollutant. Regulations were adopted by the California Air Resources Board on February 26, 2004 to protect the public from exposures to the emissions from diesel engines. Therefore, the District is providing notification that additional control requirements and/or operating restrictions may be imposed on diesel engines after the approval of the new regulations by the State Office of Administrative Law.

Lastly, this permit cannot be considered as permission to violate applicable laws, ordinances, regulations or statutes of other governmental agencies.

If you have any questions please contact me at the District office.

Sincerely,

Mary Giraudo

Mary Giraudo
Air Quality Engineer

Enclosure: Permit to Operate 11374

MONTEREY BAY UNIFIED AIR POLLUTION CONTROL DISTRICT

PERMIT TO OPERATE

11374

24580 SILVER CLOUD CT., MONTEREY, CA 93940 TELEPHONE (831) 647-9411 • FAX (831) 647-8501

OPERATION UNDER THIS PERMIT MUST BE CONDUCTED IN COMPLIANCE WITH ALL DATA AND SPECIFICATIONS INCLUDED WITH THE APPLICATION UNDER WHICH THIS PERMIT IS ISSUED. THE EQUIPMENT MUST BE PROPERLY MAINTAINED AND KEPT IN GOOD CONDITION AT ALL TIMES. THIS PERMIT TO OPERATE MUST BE POSTED OR ACCESSIBLE.

LEGAL OWNER OR OPERATOR:	WOOD WASTE DIVERSION, INC.
EQUIPMENT LOCATED AT:	Various Locations Within Monterey, Santa Cruz And San Benito Counties
EQUIPMENT DESCRIPTION AND CONDITIONS:	THIS PERMIT TO OPERATE IS ISSUED AND IS VALID FOR THIS EQUIPMENT ONLY WHILE IT IS IN THE CONFIGURATION SET FORTH IN THE FOLLOWING DESCRIPTION:

PORTABLE ENCLOSED WOOD PLANING & CHIPPING OPERATION WITH DUST COLLECTION SYSTEMS PROCESSING WOOD COATED WITH LEAD-CONTAINING PAINT:

1. Auburn Machinery Portable Wood Planer And Chipper, Rated At 3,000 Linear Feet Per Hour, (125 Cubic Feet Per Hour), And Powered By A John Deere Diesel Engine, Model T06059, Serial #T06059T402754, Rated To 165-Hp At 2,500 RPM, And Kohler Generator. Planer, Chipper And Wood Waste Hopper Located Within An Enclosed Trailer.

2. Enclosed Trailer, 8' Wide x 28' Long, With A 30" x 30" Board Feed Opening, And A 14" x 14" Board Exit Opening. Exit Opening Equipped With Board Roller Brush. Sawdust From Horizontal Spindle And Saw Blade Exhausting Via One Common Pick-Up Point To Wood Waste Hopper. Planer And Portable Vacuum Exhausting Via One Pick-Up Point Each To Wood Waste Hopper. Trailer Maintained Under Negative Pressure Via Two (2) Ryosei Heavy Duty Industrial Dust Collectors, Model RD337QLH, Serial # 20603 & 20604, Common To Wood Waste Hopper Negative Air System. Each Air Filtration Unit Consisting Of A Fabric Dust Collector With Eighteen (18) Dual Polyester Fabric Filters, 3" Diameter x 36" Overall Length Individual Filter Size, 76 Square Feet Of Filter Area, And One (1) 24" x 24" x 12" HEPA Filter. Each Unit Venting To Atmosphere Via One 5-Hp Fan, Rated At 2,500 CFM.

** Page 1 of 3 **

THIS PERMIT BECOMES VOID UPON ANY CHANGE OF OWNERSHIP OR ADDRESS, OR ANY ALTERATION.

THIS PERMIT DOES NOT AUTHORIZE THE EMISSIONS OF AIR CONTAMINANTS IN EXCESS OF THOSE ALLOWED BY ARTICLE 1, CHAPTER 3, PART 4, DIVISION 26 OF THE HEALTH & SAFETY CODE OF THE STATE OF CALIFORNIA OR THE RULES AND REGULATIONS OF THE AIR POLLUTION CONTROL DISTRICT. THIS PERMIT CANNOT BE CONSIDERED AS PERMISSION TO VIOLATE EXISTING LAWS, ORDINANCES, REGULATION OR STATUTES OF OTHER GOVERNMENTAL AGENCIES.

APCD 3

Lance Ericksen for
AIR POLLUTION CONTROL OFFICER

DATE SEP 17 2004

3. Wood Waste Hopper, 8' Wide x 8' Long, 9.7 Cubic Yards Capacity. Wood Waste Hopper Receiving Sawdust Via Two (2) Ryosei Engineering Co. Air Filtration Units, Model RD337QLH, Common To Trailer Negative Air System. Each Air Filtration Unit Consisting Of A Fabric Dust Dust Collector With Eighteen (18) Dual Polyester Fabric Filters, 3" Diameter x 36" Overall Length Individual Filter Size, 76 Square Feet Of Filter Area, And One (1) 24" x 24" x 12" HEPA Filter. Each Unit Venting To Atmosphere Via One 5-Hp Fan, Rated At 2,500 CFM. Hopper Discharging Wood Waste Via 6" Auger To Bags.

THE EQUIPMENT FOR WHICH THIS PERMIT TO OPERATE IS ISSUED MAY BE OPERATED ONLY WHEN IN COMPLIANCE WITH THE FOLLOWING CONDITIONS:

Conditions:

1. The annual amount of diesel fuel usage, linear feet of wood siding processed and the volume of wood waste collected by the dust collection system shall be reported to the District, upon request, at the time of permit renewal.

2. Wood Waste Diversion, Inc. shall maintain a daily log which includes diesel fuel usage, linear feet of wood processed, and volume of wood waste collected. The log shall be maintained on the premises and made available to District staff upon request.

3. No more than 24,000 linear feet per day of wood coated with lead-containing paint shall be processed through this equipment.

4. The 30-day average maximum off-site air concentration shall not exceed 0.30 $\mu g/m^3$ of organic lead.

5. All planing and chipping of wood coated with lead-containing paint shall be performed:

   a) within the enclosed trailer with the exhaust systems operating, and the HEPA filters in place; and,

   b) with the planed and chipped material discharging into the enclosed wood waste hopper, with the exhaust systems operating, and the HEPA filters in place.

6. Wood waste hopper auger unloading operations shall be performed with a seal around the auger, and only one of the two negative air systems turned on.

Wood Waste Diversion, Inc.
Permit to Operate 11374
Page Three:

7. After augering of wood waste is complete, both negative air systems shall be operated to clean out the auger.

8. HEPA filters shall be maintained in good operating condition.

9. No disturbance, abrading or grinding, of asbestos-containing materials shall occur from this operation.

10. The sulfur content of any diesel fuel consumed shall meet California Air Resources Board (CARB) specifications.

11. Collected material shall be stored and disposed of in such a manner so as to prevent the release of the material into the atmosphere.

12. No air contaminant shall be discharged into the atmosphere for a period or periods aggregating more than three minutes in any one hour which is as dark or darker than Ringelmann 1 or equivalent 20 percent opacity.

13. No emissions shall constitute a public nuisance.

NOTE: The annual renewal date is October 4.

Appendix B: Analytical Methods Supporting the Experimental Design

Analytical methods supporting this project were standard for a construction project, which are not as complex as may be required with other environmental technologies. The two principal analytical parameters were cost to perform the work and productivity achieved.

Both the Toxicity Characteristic Leaching Procedure (TCLP) and the California Waste Extraction Test (Cal WET) were applied to this project. It is important to recognize the applications and differences between these two testing methods, and the impact the differences has on the results returned by each method. The RCRA definition of hazardous waste for lead is 5 mg/L soluble lead, as defined by the TCLP. This standard is applied nationally. However, California uses another testing procedure to define "hazardous". In addition to the RCRA definition of hazardous, California also applies the Cal WET and Total Threshold Limit Concentration tests (1,000 mg/kg). The Cal WET generally results in higher concentrations of lead in the extraction because it uses a different acidic solution, a lower dilution factor, and a longer duration of extraction. Therefore, LBP-coated materials that pass the RCRA threshold for toxicity using the TCLP may fail the California definition as tested using the CAL WET method. In other states, whole buildings are rarely characterized as hazardous waste because the commingled debris rarely contains more than 5 mg/L of soluble lead. At Camp Roberts, the commingled building debris from previous demolition projects was characterized as California hazardous waste because the Cal WET procedure was used.

A Work Breakdown Structure will be developed to include Codes of Accounts for each relevant expenditure, by type. Costs will be analyzed by monitoring the resources applied to performing the Work. Labor cost will be determined by monitoring the labor hours invested by each individual and applying the appropriate hourly rate. Equipment cost will be determined by monitoring the equipment hours (both active and idle) invested with each piece of equipment and applying the appropriate hourly rate. Actual costs for permitting, safety training and meetings, electrical generation, site sanitary facilities, supervision, quality control, project documentation, and other job-indirect costs will be recorded.

Productivity will be determined using conventional construction productivity methods. Total production will be determined using the quantities of materials produced, recorded in conventional construction units of measure. Where weight is required, documented weights of building materials will be applied. As weights of some materials, wood in particular, is so variable depending on density (which varies even within species), humidity, and other factors, samples will be weighed to verify the reasonableness of the documented data. The total quantity of saleable product will be compared to the total mass of the standing building. A productivity rate for each task will be determined based on the total production for the task and the total labor hours and crew hours invested in the task.

Given a representative productivity, the appropriate labor and equipment rates (costs) can be applied to determine unit costs for tasks and finished products. Job-indirect costs will be distributed over the job, and applied on a per-unit basis.

The value of the finished product will be determined by monitoring sales receipts.

All data will be recorded by USARR as the Work is performed.

To validate the data, the University of Florida Center for Construction and Environment (UFCCE) and U.S. Forest Service Forest Products Laboratory (FPL) will provide observation services and sampling. UFCCE will independently monitor resources, production, and productivity of a representative array of tasks, and determine productivity and costs. They will then compare their independent observations with USARR's records. It is unrealistic to expect these two sources will develop identical data. However, results within 10-15% must be considered "equal." Note that a plus-or-minus 10% range in detailed construction cost estimating is considered to be acceptable. FPL will collaborate with wood products experts from Pennsylvania State University to validate the quality and characteristics of the resultant wood products, and will perform an independent market value assessment.

Appendix C: Data Quality Assurance/Quality Control Plan

Introduction

This appendix presents the data Quality Assurance Quality Control (QAQC) plan for the ESTCP Compliance Demonstration at Camp Roberts, CA. The project objectives are to show that LBP can be safely removed from WWII-era barracks, and that the wood recovered from these barracks can be remanufactured and sold as high value end products. The demonstration data should show that this can be accomplished while providing a cost savings alternative to simple demolition and landfilling. In addition, the data must be of such quality that it can be assumed that extrapolations to Army-wide applications of the technology are reliable.

The QAQC Team

The Chief QAQC officer shall be John Stevens, USA Resource Recovery (USARR) Principle and demonstration site superintendent. Other QAQC team personnel represent the University of Florida's Center for Construction and Environment (UFCCE) and the USDA Forest Products Laboratory (FPL), and the U.S. Army Corp of Engineers (USACE) will be represented by the Corps' Mobile District (CESAM) and the Corps' Construction Engineering Research Laboratory (CERL).

QAQC Objectives

The primary purpose of this QAQC plan is to ensure that:

1. Data generated during the course of the demonstration is of an acceptable, verifiable, and repeatable quality (quality assurance), and
2. A sufficient number of critical measurements are taken for proper data evaluation (quality control), and
3. Ensure the collected data is sufficiently reliable to extrapolate results for an Army-wide comparison.

QAQC Flow Chart

A graphic describing the structure of the quality control organization is displayed in Figure E1. It shows lines of authority and acknowledgment (CERL, USARR, UFCEE, FPL, CESAM)

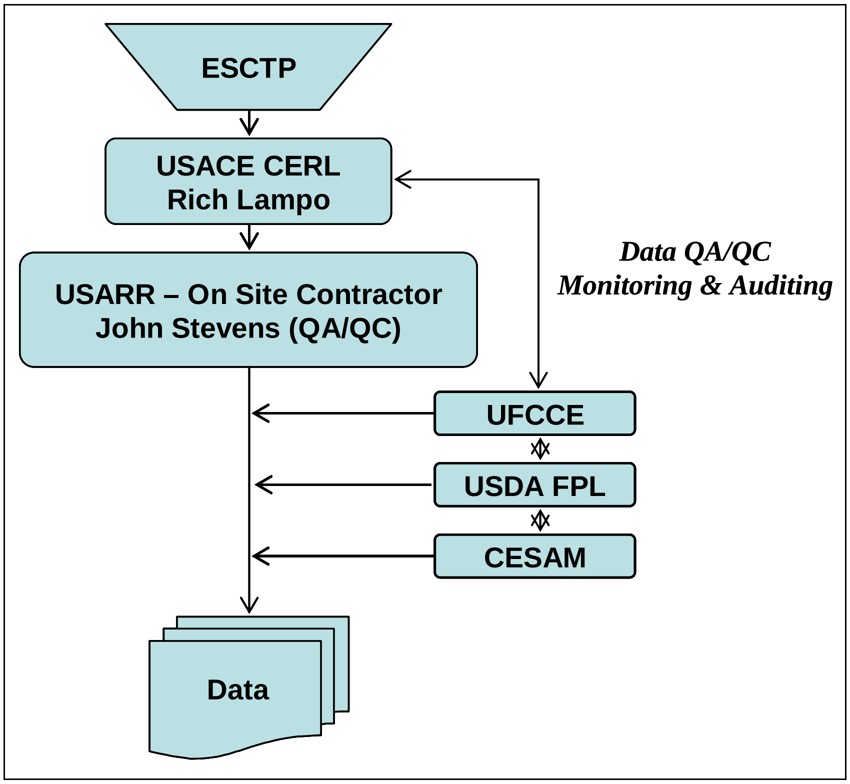

Figure E1. QA/QC Flowchart.

Data Attributes

A list of the definable steps of the work involved in this demonstration is shown below. A complete discussion of these features and the data associated with each step is presented n Chapter 3 of this plan. These steps are distinguishable by the nature of the work being completed, the skills of the personnel performing the work, or the tools and equipment required used to complete it.

1. Planning, Mobilization and Setup (time, cost, safety)
2. Deconstruction Operations (time, cost, productivity, safety)
3. Premilling Operations: De-nailing, Materials Characterization, Optimal Profiles (time, cost, quality, safety)
4. Milling Operations (time, cost, productivity, safety)
5. Post Milling Operations (specifics?)(time, cost, productivity, safety)
6. Breakdown and Cleanup(time, cost, safety)
7. Marketing: Valuation, Supply, Demand (time, cost, productivity, safety)
8. Data Evaluation, Final Report(time, cost).

Data elements are listed in Table E1 which includes the attributes and closest unit of measure for each element. The elements are associated with the definable feature of the work. As seen in this

table all of the data elements can be measured objectively (repeatability) with a simple watch and measuring tape (excluding of course the lead content in the wood and air).

Table E1. Data Elements and Attributes.

Data Element	Data Attribute – Nearest Unit of Measure			
	time	quantity	quality	tolerance
mobilization/demobilization	person-hr			±30 min
deconstruction siding	person-hr			±30 min
deconstruction roof	person-hr			±30 min
deconstruction 2nd floor	person-hr			±30 min
deconstruction 1st floor	person-hr			±30 min
deconstr hardware items	person-hr	each		±30 min
dimensional lumber		lf	reusable	±1 lf
dimensional lumber		lf	waste	±1 lf
pre-milling staging	person-hr			±30 min
milling operations		lf/hr	not idle	±100 lf/hr
post-milling staging	person-hr			±30 min
waste disposal		ton	rcra	±200 lbs
waste disposal		ton	non-RCRA	±200 lbs
market investigation	person-hr	$/hr		±30 min
market sales		$/bf		±$.50
personnel labor	person-hr	$/hr		±30 min
independent data audit	person-hr	$/hr		±30 min

Data QAQC Testing and Frequency

The QAQC team will be on site to monitor data collection for not less than three days for each building. Given that each building will take approximately 6 days to process, the QAQC team will be on site for approximately 50% of the time, or the equivalent of all day every other day. The team will make independent measurements of each process using the same instruments (watch and tape measure). Immediate comparisons will be made to the USARR data to ensure accuracy and completeness.

Monitoring Lead in the Air and Wood Products

As indicated previously in this plan, testing for lead in the air shall be monitored according to OSHA 29 CFR 1926.62 by a local, independent laboratory certified to perform these tests. The

specific laboratory that will perform these tests is yet to be determined but a qualified local laboratory is known to be available having performed similar tests at the former Fort Ord – as coordinated by the local air district and the Fort Ord Reuse Authority (FORA). The measurement of lead content in the captured waste shall be accomplished using the Toxicity Characteristics Leaching Procedure and/or the Cal-WET test as specified in guidance provided by the California Department of Toxic Substances Control.

Periodic Coordination Meetings and Review

Before start of deconstruction USARR and the QAQC team shall agree to the QAQC plan and review schedule. If discrepancies between the USARR and the QAQC team data are not immediately resolved the Government Contracting Officer's Technical Representative shall be notified at once. USARR shall ensure that at least one person overseeing data QAQC is on site at all times.

Appendix D: Ahtna Government Services Corporation Health and Safety Plan

AHTNA
Government Services Corporation

SITE SAFETY AND HEALTH PLAN
Building Deconstruction and Wood Recycling
Camp Roberts, California

Prepared for:

Department of the Army
ERDC-CERL
Vicksburg Consolidated Contracting
Champaign Office
P.O. Box 9005
Champaign, IL 61826-9005

AGSC Project Number: 30136

Contract Number: W9132T-04-R-0032

____
Randy R. Rogers
Project Manager

____
Pete Rice, C.I.H. No. 2156, C.S.P. No. 7287
Acting Corporate Safety and Industrial Hygiene Manager

November 21, 2004

1115 Shore Street, West Sacramento, CA 95691
Phone: (916) 372-2000 Fax: (916) 372-9401

Table of Contents

Appendixes

1 Introduction

This Site Safety and Health Plan (SSSHP) meets the requirements of Ahtna Government Services Corporation's (AGSC's) Injury and Illness Prevention Program and those identified in the Statement of Work. This Plan has been prepared by AGSC in conformance with applicable federal and State of California occupational safety and health regulations. It addresses activities associated with the demolition and wood recycling of buildings located at Camp Roberts including the control of asbestos as documented in the surveys completed by the US Army Corps of Engineers in October 2003 included as Appendix A. This plan will be implemented by the Site Superintendent (SS) with support from the designated Safety and Health Officer(s) (SHO) during dismantling, demolition and abatement operations.

Compliance with elements as specified in this plan is required for all AGSC personnel and subcontractors that participate in on-site abatement and demolition activities. The safety and health plan for the asbestos abatement and control of lead based paint (LBP) scraping is included as Appendix B. All subcontractors will comply with approved safety and health plans for their specific on-site activities.

AGSC maintains and implements a Corporate Safety and Health Program. This Program establishes AGSC's foundation of workplace safety and health practices and procedures. Project level safety and health practices and procedures are found in this site specific SSHP. The purpose of this SSHP is to establish practices and procedures for the recognition, evaluation and control of site specific workplace hazards and to minimize risks to personnel, equipment, materials, and the environment. Occupational safety and health inspections will be performed to include most aspects of this SSHP, including activities of all contractors. The routine inspections focus management's attention on pertinent safety and health issues and all corrective actions to be implemented in a timely fashion. For work activities covered by this plan, a Job Hazard Analysis will be completed and submitted to the Contracting Officers Representative (COR). A Job Hazard Analysis (JHA) for each feature of work is included in Appendix C.

1.1 Approvals

The final SSHP will be reviewed and approved by the Project Management (PM), Acting Corporate Safety & Health Management (Corporate S&H) and Site Superintendents. Once this SSHP has been approved, addendums or changes will require written approval by the SHO, Corporate H&S and PM.

1.2 Regulatory Drivers

This project will be conducted in accordance with various contract requirements. If the work plan includes an activity not already addressed in this SSHP, the plan will be reevaluated and revised as necessary to ensure safety and health compliance related to that activity. This SSHP has been developed to reflect the following federal, state and local requirements:

- Corps of Engineers "Safety and Health Requirements Manual"
- AGSC Corporate Health & Safety Program (2003)

- Cal-OSHA, 8CCR Chapter 4, Subchapter 7, General Safety Orders
- Cal-OSHA, 8CCR Chapter 4, Subchapter 4, Construction Safety.
- Title 29, Code of Federal Regulations, Part 1926

2 Safety and Health Personnel

The safety and health staff for this work is described in the following paragraphs. Phone numbers of emergency personnel will be posted on the jobsite bulletin board and are in Section 11 (Emergency Phone Numbers) of this plan.

2.1 Project Manager

The PM, Mr. Randy Rogers, has the overall responsibility for the management of this project. The PM will ensure that adequate resources are provided to the safety and health staff to carry out their responsibilities as outlined below. The PM will also ensure that adequate personnel and equipment resources are available to complete the project safely.

2.2 Site Superintendent

The Site Superintendent (SS), Mr. Mike Collier, will ensure that all site work is performed in accordance with contract requirements and in full compliance with this SSHP. The SS will also serve as the site emergency coordinator. The SS and SHO will conduct a daily walk-through of the site to determine safety and health compliance and take appropriate corrective actions as necessary to promote project safety and health. Also the SS is current in First Aid and CPR and has completed the OSHA certification for Electrical/Control of Hazardous Energies, Fall Protection, Materials Handling, Cranes and Rigging, Scaffolds, Excavation Safety, Stairs and Ladders, Confined Space Entry, Power Tools, and Fire Prevention.

The SS will be assisted by Mr. Anthony DeArcos with National Analytical Laboratories (NAL), a subcontractor to AGSC. Mr. DeArcos is a certified Asbestos and Lead Contractor/Supervisor, Asbestos Building Inspector, Asbestos Management Planner and Project Designer, Lead Inspector, Assessor and Project Monitor. Mr. DeArcos is also certified in both CPR and First Aid.

2.3 Safety and Health Officer

The Safety and Health Office (SHO), Mr. Michael Collier, will be responsible for all site safety and health activities and documentation in the field as appropriate. Mr. Collier has acted as the Safety and Health Officer for construction and environmental clean-up projects for the USACE and other clients for over 10 years. Mr. Collier is Red Cross Certified in CPR and First Aid and has received 40-hour HAZWOPER and supervisory training. In addition, Mr. Collier has completed the OSHA certification for Electrical/Control of Hazardous Energies, Fall Protection, Materials Handling, Cranes and Rigging, Scaffolds, Excavation Safety, Stairs and Ladders, Confined Space Entry, Power Tools, and Fire Prevention.

The SS and SHO will be assisted by Mr. Peter Rice, CIH, CSP, REHS (AGSC Corporate Safety and Health Manager (Acting)) Mr. Mike Noel, CIH (National Analytical Laboratories), and Mr. Anthony DeArcos (Personal and Air Monitoring, NAL). Mr. DeArcos will complete the onsite personal and air monitoring requirements for this project and will provide additional safety and health support as outlined in Appendix B of this plan.

The SHO is responsible for implementing this SSHP and initiating changes to the plan with the concurrence of the PM, SS, and Project CIH (Pete Rice). The SHO has stop-work authority for specific activities, which will only be executed upon determination of an imminent safety hazard or potentially dangerous situation. The SHO will be present during all project operations. The SHO has the authority to stop work if the safety and health of personnel are in danger. Mr. Collier will also serve as the Competent Person on this project (e.g. fall protection and excavation). An OSHA competent person is an individual who, by way of training and/or experience, is knowledgeable of applicable standards, is capable of identifying workplace hazards relating to the specific operation, is designated by the employer, and has authority to take appropriate actions. Mr. Collier's training and experience satisfies this requirement, is identified by AGSC as the competent person, and has the authority to take appropriate actions to include job-shut down.

2.4 Site Workers

All site workers, including subcontractors, must be familiar with and agree to comply with the terms and conditions of this SSHP. All site workers have the responsibility to immediately report any unsafe or potentially hazardous condition to the SHO or the SS, stop work if a hazard, accident or injury is foreseen, and correct the hazard.

3 Project Description

Under this contract AGSC will perform field activities associated with the deconstruction and recycling of the buildings at Camp Roberts. This will include, but not necessarily be limited to, the following work elements:

- Prepare this Safety and Health Plan and Job Hazard Analysis plans including asbestos abatement and lead-based paint hazard control as well as personnel monitoring procedures to be followed during site operations.
- Lead-based Paint (LBP) management and abatement.
- Abate asbestos in the floors, roof, and the interior wall and transite panels identified in the Asbestos Survey dated October 2003.
- Remove roofing material as required.
- Dismantle buildings taking care to protect as much as possible all recyclable material.
- De-lead wood on-site with Wood Waste Diversion Incorporated milling and lead removal equipment according to the Monterey Bay Unified Air Pollution Control District (MBUAPCD) Permit No. 11374 (Appendix M).
- Remove and dispose of all concrete blocks and or foundation.
- Any utilities encountered will be capped and abandoned in place.
- Former building locations will be backfilled and matched to grade using soil or native fill material.

3.1 Features of Work

This project has several definable features of work, as outlined below:

- Mobilization/Demobilization
- LBP Management/Abatement
- Asbestos Abatement
- Building Dismantling/Demolition
- Site Restoration.

3.2 Mobilization/Demobilization

Mobilization will include the transportation of equipment and personnel to the site. The equipment and personnel staging area will be established and secured prior to equipment mobilization. All preconstruction submittals and permits will be obtained and approved prior to mobilizing to the site.

3.3 Roof Shingle Removal

Roof shingles will be removed, stockpiled on pallets, and shrink wrapped. The pallets will be transported to a storage facility on base and offloaded. All work completed on the roof will be according to the safety guidelines established by this plan.

3.4 Asbestos Abatement, Lead Control, Disposal Facility and Transporter

Asbestos abatement and lead control will be completed as identified in Appendix B. In addition the lead paint will be removed using the industrial process as documented in the permit to operate issued by the MBUAPCD (Permit No. 11374) included as Appendix M. Separate storage bins will be provided for each waste stream of material for disposal. All contaminated or hazardous material will be characterized and disposed of at appropriate disposal locations (potential locations include the Marina Landfill and or Kettleman Hill Class 1 Landfill). After completion of the waste characterization and prior to removal of any material from the site an authorized government representative will review the waste stream characterization and will approve the selected landfill, waste transporter, and sign all manifests.

3.5 Dismantling Procedures

After all abatement work has been completed in accordance with the procedures outlined in Appendix B, the buildings will be dismantled using power and hand tools where possible and mechanical equipment if required. All elevated work will be completed from manlifts, when appropriate. Material will be removed from the building and stockpiled by category. Any painted material will be stockpiled and the lead paint removed.

3.6 Sequence of Operations

After approval to begin work is granted by the COR, work will proceed as outlined below:

1. Mobilization to the site
2. Roof shingle removal
3. Asbestos abatement of the roof, wall and floor areas
4. LBP control
5. Building dismantling
6. Wood recycling
7. Foundation demolition
8. Waste characterization, transport, and disposal
9. Site restoration
10. Demobilization.

It is important to note that some of the phases of work will overlap. Prior to the commencement of dismantling activities, all asbestos and LBP abatement activities will be completed. A project schedule has been prepared and is presented in Appendix D.

4 Hazard Assessment

4.1 Introduction

This hazard assessment presents the hazards anticipated during the project-related activities and reviews control strategies. The chemical, biological and physical hazards for each type of operation are presented. A complete Job Hazard Analysis (JHA) is presented as Appendix A. The JHA Table addresses the typical hazards and types of controls for each of the specific activities. As new activities are identified or existing activities modified, the JHA will be revised.

4.2 Activities Identified as Potentially Causing Chemical Exposures

Some of the planned site activities have the potential to expose workers to hazardous materials during work, including:

- Lead Based Paint Removal
- Asbestos Abatement
- Diesel and other exhaust
- Response to spills
- Exposure to diesel and gasoline fuels during handling
- Silica (from concrete breaking).

Lead paint control and asbestos abatement is covered in the Abatement Safety and Health Plan included as Appendix B. All work will be completed using wet methods to minimize exposure. When possible, work will be performed by employees working upwind of exhaust, debris removal and concrete breaking operations.

Employees exposed to the breaking of concrete will be monitored with a portable aerosol monitor (e.g. personal *data*RAM). Employees exposed to greater than 0.1 mg/m^3 (sustained for greater than 5 minutes) will be required to don Level C respiratory protection and dust control procedures will be upgraded.

4.3 Physical Hazards

Potential physical hazards associated with the site include noise, heavy equipment operation, heat / cold stress, fires, structure collapse, material handling, underground or overhead utility lines, slips, trips, falls, etc.

Each activity may have the same hazards present but at differing degrees of risk. The JHA in Appendix C presents the hazards associated with the general tasks to be completed. Controls are presented which can reduce or eliminate the risk of the hazard occurring.

4.3.1 Noise

Operations such as heavy equipment use, generators, strippers, and jackhammers are anticipated to have varying degrees of noise associated with them. All activities performed in areas at noise levels above 85 decibels (A scale) will require the use of hearing protection.

Reference:

- 29 CFR 1910.95 Hearing Conservation
- Cal-OSHA, 8CCR-Article 105 (Control of Noise Exposure).

4.3.2 Heavy Equipment Operation

Heavy equipment operation will involve loaders, forklifts, excavators, generators, manlifts, bobcat and other types of equipment. The potential hazards involve striking workers, spillage of materials, pinch points, fires, and other hazards. All heavy equipment will be equipped with fire extinguishers, seatbelts, and backup alarms. An equipment inspection will be conducted according to manufacturer's specifications and the appropriate inspection checklist (see Appendix E for example checklist) will be completed on each piece of equipment prior to use. When equipment is being fueled, spill control equipment will be available. Employees will work in specific areas and employees will wear high visibility apparel (e.g. safety vests or shirts) and avoid working in areas that will subject them to being struck by heavy equipment. Employees required to work in the vicinity of heavy equipment operations will do so only after discussing the nature of the work, making eye contact with the equipment operators, and maintaining that contact throughout the work activity. All heavy equipment operators will be trained and experienced (certified if required) for each piece of equipment for which they will operate.

4.3.3 Utility Locates

During demolition, underground or aboveground utility lines or other buried objects may be encountered. A utility survey will be conducted at the site and all utilities will be removed, isolated and or capped as required. No underground or aboveground work in an area will be conducted until all utilities are located and hazards controlled. The main power disconnect will be disconnected at the power pole and all breaker boxes in the building will be stripped and deactivated.

References:

- USACE, Site Safety and Health Manual, EM 385-1-1.

4.3.4 Materials Handling, Lifting and Rigging

Employees will be trained in the proper rigging and lifting techniques during site-specific training activities. In general:

- Materials handling equipment should be used for all lifting tasks, if possible.
- Employees must be aware of their limitations, and ask for help of necessary.
- Large (over 50 pounds) or awkward loads will be lifted with two employees at a minimum and/or materials handling equipment.

The SS will check that appropriate equipment is available when it is necessary to move heavy equipment or objects. The use of slings, wire rope or chains to lift objects will comply with the requirements of T8-CCR, Group 13. When hoisting loads, a positive latching device will be used to secure the load and rigging. Loads will not exceed the rate capacity of the sling, rope, or chain. Excavators, slings, chains, and ropes will be inspected daily. An equipment inspection form is to be filled out prior to beginning work (Appendix E).

References:

- 29 CFR 1910.184
- USACE, Safety and Health Manual, EM 385-1-1, Sections 14 and 15
- Cal OSHA, 8 CCR.

4.3.5 Confined Space Entry

This site has been inspected for confined spaces. Confined spaces entry is not anticipated nor expected as part of this work assignment. No confined spaces will be entered under any circumstances during this project until a confined spaces entry program has been developed and implemented.

4.3.6 Illumination

Illumination on the job site will be supplemented using a generator and portable light stations as necessary to ensure that site activities and access/egress routes are properly lit. All illumination equipment will be UL listed and appropriately grounded.

References:
- T8-CCR, Section 1523

4.3.7 Slips, Trips, and Falls

Slips, trips and falls are a potential source of trauma because of working surfaces, debris and temporary utilities lines and uneven flooring. Because of the deteriorated condition of the buildings, the potential for trauma injuries increases. Personnel may encounter wet or uneven walking surfaces during the field effort. ANSI Z41.4-approved work footwear and careful attention to the work surfaces and immediate vicinity is necessary to prevent injuries. Slip, trip and fall hazards will be identified and flags or tape used to mark those that cannot be readily removed. All walking and working surfaces will be inspected by the competent person for structural integrity and potential hazards before employees are allowed to work upon.

References:
- T8-CCR, Sections 3273 and Subchapter 4, Article 19 et.al.

4.3.7.1 Roof Shingle Removal Fall Protection

No employee will work at a threshold height 6 feet above a working surface or other hazard without fall protection (i.e. protected by guardrails, safety nets, or having donned personal fall protection). 100% fall protection is required on this project.

Roof work areas will be provided with an alternate safe means of access and egress, such as a ladder that conform to the provisions of T8-CCR, Article 25. The manlift will be readily available at all times to assist workers while working aloft.

All fall protection equipment must be inspected prior to each use and must be maintained in good working order at all times. Equipment or components found to be defective must be immediately removed from service and replaced.

Distance requirements for the fall protection system are as follows:

- The fall protection system must not allow for more than a 2-foot free fall.
- The fall protection system must be used and secured in a fashion so that the user cannot contact the next lower level should a fall occur. This includes; Free Fall Distance, plus System Elongation, plus Deceleration Device/Shock Absorbers, Plus Employee Height (distance from anchor point to D-ring).

References:
- T8-CCR, Article 24 (Fall Protection), Sections 1669-1671.2

4.3.8 Weather (Hypothermia, Frostbite, High Winds, Heat Stress)

Weather conditions in the central valley of California can be unpredictable and extreme, and caution against weather related hazards (hypothermia and heat stress) should be exercised at all times.

Because prolonged exposure to cold air or wind at temperatures below freezing may lead to hypothermia, monitoring of personnel is essential. The early signs of cold stress are shivering, numbness, and pain the extremities. Hypothermia, the most serious form of cold stress, is indicated by sleepiness, loss of motor control, failing eyesight, and loss of consciousness. The SHO will verify that workers are properly clothed in insulated dry clothing whenever air temperatures are below 40° F. If work is to be performed continuously at temperatures below 32° F, heated warming shelters or vehicles will be available. Workers will be required to use the shelters at regular intervals: frequency of use will depend on the severity of the conditions. If a worker's clothing becomes wet, the worker will put on dry clothing before returning to work. Warm, decaffeinated beverages will be provided at the work site to provide calories and fluid volume. A worker with hypothermia will be moved to a warm, dry area. Cold or wet clothing will be removed and warm, dry clothing and/or blankets provided. For severe cold stress, workers will be examined by a health-care professional as soon as possible.

Heat stress on this project is unlikely, due to the time of year the work will be performed, however possible. The potential for heat stress is greatest for workers wearing protective clothing. Depending on the ambient conditions (e.g. above 70 degrees Fahrenheit) and the work being performed, heat stress can occur rapidly. In its early stages, heat stress can cause rashes, cramps, discomfort and drowsiness, resulting in impaired functional ability that threatens the safety of both the individual and coworkers. Continued heat stress can lead to heat stroke and death. Below are listed some general safe work practices to avoid heat stress. For strenuous field activities that are part of ongoing site work activities in hot weather, the procedures identified in Appendix F will be followed.

1. Increase water intake while working. Avoid sodas.
2. Minimize and/or avoid alcohol intake the night before working in heat stress situations.
3. Increase the numbers of rest breaks and/or rotate workers in shorter work shifts; take breaks in shaded areas.
4. Use the Buddy System. Watch for signs and symptoms of heat exhaustion and fatigue.
5. Plan work for early morning or evening during hot months.
6. Use ice vests when necessary.
7. Rest in cool dry areas.
8. In the event of a heat stress condition, place victim in a cool, shaded area. Cool the victim with cold cloths. Do not use ice directly on the skin. Cool the temperature control areas of the body (e.g. forehead, back of neck and wrists).

Heat Stroke is a Medical Emergency. If a person has heat stroke, seek medical attention immediately.

Also, employees will take the necessary precautions to prevent exposure to excessive ultraviolet light (e.g. sunburn). As appropriate, employees will wear sunscreen and wear clothing to minimize skin exposure to the harmful effects of the sun.

4.3.9 Natural Disasters

4.3.9.1 Earthquake

In the event of an earthquake, all personal will immediately evacuate the roof to a safe distance from the buildings. When safe, proceed to the staging area for a head count. If in the building, proceed immediately to a safe location, such as a doorway. When safe, proceed to the staging area for a head count.

4.3.9.2 Structural Collapse

The buildings will be inspected daily for changes in conditions. Notice should be paid to any creaking or shifting noises. If unusual noises are heard the building shall be evacuated until the safety of the building can be evaluated.

4.3.10 Biological

Although not expected, there is the remote possibility of exposure to small mammals (i.e. raccoons, skunks, squirrels, mice and dogs) and insects (i.e. spiders, bees, wasps). Also, at the site poison oak exposure is possible. Site personnel will not approach any animal. If observed, employees are to contact the SHO for possible summonsing of animal control personnel and /or exterminator. Be aware that the area may have bees, hornets and other insects. If a hive is found notify the SHO and Competent Person immediately for subsequent extermination.

Certain mice species have the potential to harbor the disease known as Hantavirus or more accurately Hantavirus pulmonary syndrome (HPS). Hantaviruses that cause HPS are carried by rodents, especially the deer mouse. A worker can become infected by exposure to their droppings. If employees enter a space that may have recently harbored mice, a survey of the space is necessary. Common signs of rodent infestation guidelines are presented in Appendix L. Should signs of rodent infestation be identified, work will stop, the space closed, marked as “Do Not Enter” and the client and Project CIH representative will be contacted immediately for guidance. Employees are not permitted to enter a potentially HPS workspace.

4.3.11 Scaffolds

AGSC employees are not anticipated to work on scaffolds. However, scaffolds may be used by subcontractors and will follow those requirements as specified by OSHA. AGSC’s SHO and the abatement contractor’s competent person shall:

- Inspection of all equipment by a competent person the scaffold user before use
- Remove damaged/defective equipment from job site
- Supervise all erection, dismantling, alteration or movement of scaffolds.

4.3.12 Ladders

Ladder use, inspection, and care will be in accordance with those safe work practices identified in Appendix G.

4.3.13 Excavations

No excavations are expected below footing level. Footings are not anticipated to be deeper than three feet.

4.3.14 Demolition (General)

Demolition hazard control involves implementing measures which reduce the risk at the site. The following bulleted items will be implemented and those requirements adopted from Cal OSHA's Article 31 (T8-CCR) will be followed (see Appendix H).

- Demolition work shall at all times be under the immediate supervision of a qualified person with the authority to secure maximum safety for employees engaged in demolition work.

- Prior to permitting employees to start demolition operations, the qualified person will make a survey of the structure to determine the condition of the framing, floors, and walls, and the possibility of an unplanned collapse of any portion of the structure. Any adjacent structure where employees may be exposed shall also be similarly checked.

4.3.15 Dust and Dust Control

Airborne particles of a potentially hazardous nature may be anticipated as part of the work. Operation of equipment and other activities may result in elevated concentrations of airborne particles (e.g. silica from the breaking of concrete). Inhalation of dust may result in increased exposure to particulate-bound chemicals and risk of pneumoconiosis. Signs of exposure are visible dust in normal light, irritated eyes and respiratory tract, and congested nasal passages. To prevent overexposure, dust control measures (e.g. water spray) will be implemented when needed to reduce dust levels. Work will be halted during periods of airborne dust greater than 0.1 mg/m^3 (see discussion below) in the workers breathing zone as measured with a portable aerosol monitor (i.e. personal *data*RAM). Until dust levels are sufficiently low that operations may continue, air-purifying respirators with high-efficiency particulate air (HEPA-P100) cartridges will be used as determined by the SHO.

Note: ACTION (TRIGGER) LEVEL CALCULATIONS
Assumptions:
1. Silica is a contaminant with potential for employee exposure on-site and is not addressed in the asbestos and lead abatement plan (Appendix B).
2. Controlling silica exposure to less than the Permissible Exposure Levels is necessary.
3. Maximum silica concentration in soil is 100%.
4. Allowable silica concentration in air = (0.1 mg / m^3)*.

Calculations:
1. The allowable dust concentration in air is calculated as:
- Allowable dust concentration = Allowable silica concentration in air (mg/m^3) / Concentration of silica in dust = 0.1 / 1

Industrial Hygiene Monitoring

In addition to real-time air monitoring, samples using traditional industrial hygiene techniques may be collected for lead and/or other airborne contaminant analysis (e.g. silica) as described below if airborne dust levels cannot be controlled to less than the airborne dust trigger levels.

All monitoring shall be conducted by trained and certified industrial hygienist (CIH) and/or industrial hygiene technician under the direction of a CIH. The levels of concern for air contaminants from sample monitoring will be the Cal/OSHA Permissible Exposure Limits (PEL's) and Action Level for inorganic lead. The Cal/OSHA PEL and Action Level for Inorganic Lead are specified in Table 1.

Initial Exposure Assessment

Initial exposure assessment will be performed to evaluate PPE requirements for onsite workers and dust control measures for protection of site workers. As noted above, if airborne dust cannot be maintained below the Airborne Dust Trigger Level (see below and Attachment 15), air sampling for inorganic lead will be performed within the workers breathing zone (OBZ). At least one worker representing each work task who would be expected to have the highest "worst case" potential for exposure shall be selected for sampling for inorganic lead monitoring. Also, perimeter sampling will be conducted at a minimum of two locations including one upwind and one downwind to assess airborne lead in the ambient air.

Daily Monitoring

If analytical results from the initial exposure assessment are less than the PEL or Action Levels then a downgrade in PPE may be made upon agreement from the client, the AGSC SS and SHO and the Project CIH. However, if analytical results indicate that sample concentrations are greater than the PEL, monitoring will be continued on at least a daily basis until additional dust suppression measures are implemented and lead analytical results indicate that sample concentrations are less than the PEL.

Sample and Analysis

Sample Collection: Air samples will be collected with air monitoring pumps in accordance with the NIOSH Methods 7300 (lead). Procedures outlined in the NIOSH Manual of Analytical Methods for monitoring are as follows:

1. For lead sampling, the preferred collection device will be the 37-mm diameter air sampling cassette with a 0.8 micrometer mixed cellulose ester filter.

2. Sampling pumps will be calibrated before and after use with a representative sampler installed between the pump and calibration devices.

3. For personal sampling, fasten the (uncapped) cassette to the workers lapel. The inlet should be oriented downward. Other sample cassettes should be placed upwind and downwind of the work area at an elevation of 4 to 6 feet above ground surface (human breathing zone).

4. Each set of samples will include 10% field blanks for QA/QC purposes. Open the field blank cassettes and other cassettes just prior to sampling. The top covers and field blank cassettes will be stored in a clean area (i.e. closed freezer bag) during the sampling period.

5. For lead sampling, sample at 1 L/min or greater (to a maximum of 4 L/min). NIOSH regulations specify a minimum sampling volume of 50 L and a maximum sampling volume of 2,000 L.

6. After the approximate volume of sample has been collected, replace end plugs.

7. Ship samples to the analytical laboratory in a rigid container with sufficient packing material to prevent damage.

Sample Analysis: Air samples collected during this project shall be submitted to the analytical laboratory and analyzed as follows:

1. Samples will be delivered to a designated American Industrial Hygiene Association (AIHA) accredited laboratory on a shift basis so that verbal reports on air sample results can be obtained within 12 to 24 hours after collection.

2. Lead samples will be analyzed in accordance with the NIOSH Method 7300 inductive coupled ion plasma (ICP).

Other additional air monitoring may be necessary during the project as required by Cal/OSHA, by the client's representatives and as determined by the SHO and/or Project CIH.

Table 1 - Permissible Exposure Limits for Potential Chemical(s) of Concern to include Effects and Pathways of Exposure
(Additional information is found in Attachment 2)

Chemical Constituents (CAS No.)	OSHA PEL ACGIH TLV ACGIH STEL NIOSH IDLH	Characteristics	Chemical and Physical Properties	Route of Exposure	Symptoms of Exposure (short term)
Lead 7439-92-1	PEL: 50 ug/m3 Action Level: 30 ug/m3	Bluish-white or silvery grey solid in various forms. Turns tarnished on exposure to air.	BP: 2680°F VP: NA UEL: NA LEL: NA FLP: NA IP: NA	INH ING CON	Effects on the gastrointestinal tract, blood, central nervous system and kidneys, resulting in colic's, shock, anemia, kidney damage and encephalopathy. Exposure may result in death. The effects may be delayed. Medical observation is indicated.

4.3.16 Alcohol and Drug Prevention

This project will be considered an alcohol and drug-free workplace:

In order to ensure AGSC's commitment to quality work and a safe work environment, every supervisor, employee, and visitor has a right to work in an environment free from the effects of abuse of alcohol and other drugs.

AGSC's policy prohibits the unlawful use, sale, dispensing, transfer, and possession of controlled substances, alcoholic beverages, drugs **not** medically authorized, or any other substance that may impair an individual's work performance or pose a hazard to the individual, public, or other employees or its property, and at any of its activities.

Each supervisor, employee, and visitor has the responsibility to adhere to this policy. AGSC may also take disciplinary action up to and including dismissal, and possible criminal prosecution toward policy violators.

4.3.17 Hazard Communication

Site-specific hazard communication information will be communicated at the job site to enhance employee and subcontractor safety and health. The purpose of the hazard communication program is to provide information about manufactured hazardous substances, including chemicals, and establish safe work practices and procedures to control exposure to those hazardous substances and chemicals. The program involves container labeling, use of material safety data sheets (MSDS's), and personnel information and training. Site-specific training will include a pre-field safety meeting, daily tailgate safety meetings, and task-specific training as determined by the SHO. All MSDS's for onsite hazardous substance products (e.g. acetylene, oxygen, and gasoline) will be maintained onsite at or near their respective locations and reviewed concurrently with the Hazard Analysis for each activity. No one is to bring hazardous substances or chemicals onto the job site without expressed authorization from the Site Superintendent or SHO. All hazardous substances brought onto the job site will be accompanied by an MSDS. Employees shall avoid exposure to hazardous substances. MSDS's for all hazardous substances are included as an attachment (Appendix I) to this document.

Also, the Proposition 65 poster shall be placed to serve as a warning to employees and the public. The poster will be placed at the entrance to the site and on the bulletin area where on-site workers would normally go to review company postings and written information.

4.3.17.1 Hazardous Energy - Electrical – Assured Grounding – Lockout Tagout

AGSC recognizes that many accidents happen around machinery of some type. Often, the accident involves electrical shock, burns or exposure to hazardous materials or moving machinery. These accidents share one thing in common: the uncontrolled release of energy, and not controlled through Lockout-Tagout. LOCKOUT is a locking device, such as a padlock, placed on a power source to prevent the release of hazardous energy that could set a machine in motion or otherwise endanger an employee working on the machine. Locks will be used with a lockout device that holds an energy control point, such as a switch, lever or valve, in the off position, making it impossible to operate.

A TAGOUT is a written warning telling all others not to operate a switch or valve that could release hazardous energy or set a machine in motion. The tag-out is placed prominently on the switch or lever so as to be noticed. Energy, left uncontrolled, can be very dangerous. Energy, simply defined, is the capacity for doing work. Kinetic (moving) energy is the force caused by the motion of an object, such as a spinning flywheel. Potential (stored) energy is the unseen force inside an object when not moving, such as a spring under tension. There are many sources of energy which can provide power to machinery. These include:

- Gravity
- Electrical
- Mechanical
- Chemical
- Hydraulic
- Pneumatic
- Thermal
- Nuclear

On this project, electrical energy offers one of the greatest potential for employee injury and will be controlled with the implementation of the following bullet practices and implementation of AGSC 's Lockout-Tagout (Control of Hazardous Energy) Program (see Corporate Safety and Health Manual).

- All 120-volt, single-phase, 15- and 20-ampere receptacle outlets, which are not a part of the permanent wiring of the building or structure and which are in use by site workers, shall have approved ground-fault circuit interrupters for personnel protection. Receptacles on a two-wire, single-phase portable or vehicle-mounted generator rated not more than 5kW, where the circuit conductors of the generator are insulated from the generator frame and all other grounded surfaces, need not be protected with ground-fault circuit interrupters.
- Each Forman is responsible for inspection of all cord sets, attachment caps, plugs and receptacles of cord sets, and any equipment connected by cord and plug to a power supply for external defects such as deformed or missing pins or insulation damage and for possible internal damage.
- Tests by a qualified person shall be performed on all cord sets, receptacles, and cord-and-plug connected equipment and are required to be grounded as follows:
    - All equipment grounding conductors shall be tested for continuity and shall be electrically continuous.
    - Each receptacle and attachment cap or plug shall be tested for correct attachment of the equipment grounding conductor. The equipment grounding conductor shall be connected to its proper terminal.
    - All required tests shall be performed:
      (1) Before first use;
      (2) Before equipment is returned to service following any repairs;
      (3) Before equipment is used after any incident which can be reasonably suspected to have caused damage (for example, when a cord set is run over); and
      (4) At intervals not to exceed 3 months, except that cord sets and receptacles which are fixed and not exposed to damage shall be tested at intervals not exceeding 6 months.
    - Records of the necessary testing shall be maintained in field logs.

5 Training and Record Keeping Requirements

In compliance with 29 CFR 1910.120, personnel performing activities associated with hazardous waste will have completed the 40-hour HAZWOPER training and an annual refresher course within 12 months before fieldwork begins and will carry a copy of the corresponding documentation or keep it in a vehicle onsite. The SSHO will have the materials available to conduct respirator fit testing onsite.

The SS and SHO will have completed an 8-hour supervisor course for hazardous materials/waste operations. The course will have included, at a minimum, health hazard recognition, equipment training, safe work practices, respiratory protection training, personal hygiene training, and specialized training for specific hazardous materials.

Workers who might have the opportunity to conduct trench and/or excavation entry shall be trained in trench and excavation safety. A competent person will be on-site to inspect the site daily and whenever required (i.e. following a rainstorm). The Trench and Excavation Safety Checklist (see Attachment 1) will be completed by the Competent Person and PEI's Trench and Excavation safety procedures will be followed. The Cal OSHA Excavation Permit will be available on-site.

Workers who might enter confined spaces will have had training specific to their assigned duties. Documentation of training will be kept onsite and will be available for review. All confined space entry is expected to be non-permit required.

If elevated construction-related work (greater than 6 feet above the work surface) is required, personnel will be trained in the fall protection system to be used such as personal fall arrest systems or personnel lift equipment.

Ladder inspection, use, and care requirements are identified in Attachment 12. A field safety meeting will be held to train project staff using ladders in ladder inspection, use, and care.

Lead awareness training for all workers with the potential for exposure to lead. Lead awareness training includes: content of the lead in construction standard (T8-CCR, Section 1532.1); nature of operations that could result in exposure to lead; purpose, selection, fitting, use, and limitations of respirators; purpose and description of medical surveillance program and medical removal protection; engineering controls and work practice controls; content of "lead compliance plan" if necessary; instructions to employees that chelating agents should not be routinely used, and; employees right of access to medical and exposure records.

In addition to emergency response training covered in the 40-hour HAZWOPER training, site-specific emergency response training will be covered in the initial site safety meeting and in daily tailgate meetings. Information will cover things such as evacuation meeting points, potential emergencies, and onsite hazards.

Visitors will be required to sign in with the AGSC representative on site before entering the site and go through the necessary safety briefing of potential hazards.

5.1 Site Specific Training

The SHO or designee will provide and document site-specific training during the project site kick-off meeting and whenever new workers arrive on site. No site workers will be allowed to begin work on site until the site-specific training and that training specified in the JHA's is completed and documented by the SHO.

This training will address this SSHP and all safety and health issues and procedures pertinent to site operations.

As part or the site-specific training, the following will be covered:

- Symptoms of exposure to chemical and biological hazards on site.
- Chemical, physical and toxicological properties of any possible site (e.g. lead, silica) contaminants.
- 100% fall protection requirement
- Lead and asbestos awareness training for employees with potential exposure to lead and/or asbestos above their respective action level and permissible exposure level.
- Hazard communications for materials brought on site.
- Safe work practices as specified in this SSHP and those specified in the JHA.
- Fire extinguisher training.
- Use, limitations, and proper fit of PPE.
- Emergency actions, routes to hospital, emergency communications.
- Additional training as specified by the SS, SHO, Project CIH

The field team roster is required to be signed by each employee after site-specific training is completed.

5.2 Safety Briefings

Site workers must participate in "daily" tailgate safety meetings led by the SHO. Tailgate meetings are also required when existing risks change and/or when new risk(s) have been identified. Updates to work practices, site hazards, emergency procedures, and evacuation routes will be addressed at each briefing.

5.3 First Aid and CPR Training

At a minimum, their will be a minimum of two workers on-site with current first aid and cardio-pulmonary resuscitation (CPR) training. Persons trained in first aid and CPR will receive instruction on blood-borne pathogens per CFR 1910.1030 and Cal-OSHA, 8 CCR, Chapter 5193. At least 2 people trained in First Aid/CPR will be onsite at all times.

References: T8-CCR, Section 1512

5.4 Record Keeping and Reporting Requirements

All safety and health record keeping and reporting requirements mandated by Cal-OSHA 8 CCR Chapter 14300, and Fed OHSA (29 CFR 1904) and other record keeping requirements (i.e. hazard

communication and Access to Employee Exposure and Medical Records) will be strictly followed. These records will be kept in a three ring binders called the Project Safety and Health Log Book and will be updated daily. These records will include the following: accident/incident reports, air monitoring data, calibration logs, close-out safety reports, daily inspection reports, exposure reports, field change requests, material safety data sheets (MSDS's), medical and training records, OSHA Form 300, Safety Meeting Logs, Visitors Log, and other safety and health correspondence or records. In the event of an on-the-job death, serious injury, or illness, the SS will notify the local Cal OSHA District Office and the COR immediately, but no later than 8 hours after becoming aware of the incident.

6 First Aid Equipment and Supplies

A physician approved first aid kit is located in the jobsite job box including an eyewash station. A field first aid kit and another eyewash station will be located at the control point of the exclusion zone. The contents of the first aid kit will be inspected weekly and replenished as soon as inadequacies are identified and/or used. The SS and the SHO will be certified in first aid and CPR. Persons whose injuries require transportation to a physician or medical facility will be accompanied by the SS, SHO, or by an employee certified in first aid. If the injury is potentially life threatening, contact 911 immediately.

7 Personal Protection

The level of protection will be established using background information and on-going monitoring of atmospheric chemical hazards using a combination of stationary sampling equipment, personal monitoring devices, and periodic monitoring with direct-reading instruments.

7.1 Personal Protective Equipment (PPE)

Prior to donning the minimum Level D protection (i.e. hard hats, safety glasses, steel-toe boots, and gloves) workers will be required to inspect their equipment for cracks, holes, abrasions, etc. Tyvek body clothing will be worn if contact with lead, asbestos or other recognized hazardous substance is possible during the completion of the work task. If any abnormalities are found, the worker will report the defect to the SHO and receive replacement equipment as necessary. As part of the safety and health inspections, and after an exposure or personal injury, the effectiveness of the PPE program will be evaluated.

Leather gloves will be used during activities when there is no contact with any substance that could potentially absorb through the skin. Safety glasses are intended for use when no chemical or physical eye hazard (i.e. laser, welding flash) is present.

If protective footwear (e.g. steel-toed boots) and other PPE and/or clothing come into contact with hazardous substances (e.g. lead and/or asbestos), they will not be worn off-site unless decontaminated, potentially contaminating vehicles and/or residences.

Workers exposed to vehicular and heavy equipment operations will don high visibility clothing (i.e. safety vest) in conformance with the ANSI/ISEA specifications. See Appendix J for details.

Subcontractors are expected to provide the necessary PPE for their own employees. The subcontractors PPE and PPE program is subject to inspection by AGSC project management and site-safety and health personnel.

7.1.1 Safety Equipment

AGSC will supply and maintain hard hats, gloves, body, fall, hearing, and foot and eye protection to all AGSC employees. All subcontractors will be required to supply approved PPE in accordance with this plan for their employees while working on this contract. AGSC will also provide basic emergency and first aid equipment in readily accessible and identified locations as follows:

- 2 physician approved first aid kits.
- 3 ABC fire extinguishers (20-pound).
- 2 emergency eyewashes.

8 Communications

A variety of communication systems will be used for on- and off-site communication. These include cellular telephones, two-way radios, hand signals, and postings. The exact type and method of communication will depend on the situation at hand. In general, emergency communications will be by two-way radio and telephone.

9 Sanitation

Eating, drinking, chewing gum or tobacco, and smoking are prohibited during work operations unless on break in a designated area. Employees will wash their hands and face prior to eating, drinking, chewing gum, or use of tobacco products. Also employees are required to wash and physically remove debris from their work clothing prior to leaving the site for errands, breaks, or leaving for the day. Toilet and hand washing facilities will be located on site. Potable drinking water will be made available for use by site personnel.

10 Site Control, Decontamination & Additional Safe Work Practices

10.1Site Control Measures

The SHO will be responsible for establishing site-specific work zones and for maintaining site access, communication, and security.

Exclusion Zone
An exclusion zone (hot zone) will be established where workers will be exposed to hazards. The exclusion zone will encompass the area within 25 feet of an active work operation. This will be increased to 50 feet and more depending upon the hazard. The SHO may modify the dimensions of the exclusion zone to accommodate site-specific constraints such as traffic patterns or permanent structures. Only project personnel with the proper PPE, training, and medical authorization who are involved with work activities will be allowed inside the exclusion zone.

The exclusion zone / regulated area shall be demarcated in any manner that minimizes the number of persons within the area and protects persons outside the area from exposure to hazardous substances.

AGSC shall post the following warning signs in each regulated area or work area where an employees exposure to lead is above the PEL.

"WARNING
LEAD WORK AREA
POISON
NO SMOKING OR EATING"

Access to the exclusion zone / regulated areas shall be limited to authorized persons and to persons authorized by the SS and/or SHO.

All persons entering the exclusion zone / regulated area where employees are required to wear respirators shall be supplied with a respirator selected in accordance with this SSHP.

Employees are not eat, drink, smoke, chew tobacco or gum, or apply cosmetics in the exclusion zone / regulated area.

Contamination Reduction and Support Zones

A contamination reduction zone will be defined around the exclusion zone by means of a barrier system by extension of the radial distance from the contamination point an additional 10 feet or to physical abutment or other permanent boundary. A contamination reduction corridor and "step-off line" will be set up at the work zone access and egress points. The contamination reduction corridor will include an access route to the current work location from the equipment decontamination area and personal decontamination area.

The personnel access point will be through a contamination reduction corridor adjacent to a personal decontamination area. All personnel entering or leaving the exclusion zone and work areas will pass

through designated corridors to don or remove their protective equipment. Personnel will not be permitted to exit the regulated area until contaminated clothing and equipment have been removed and/or cleaned properly. The exit from the clean side of the decontamination area will allow egress to the clean or support zone or to an adjacent break area.

A decontamination area will be established in the contamination reduction zone and all motorized and large equipment will be initially cleaned in this area and proceed to a main decontamination area (staging area) for final decontamination.

All personnel entering the contamination reduction or exclusion zones shall have documentation that they have successfully completed all training; respirator fit testing, and medical surveillance requirements.

Support Zone

The support zone will include all areas not involved immediately with the work and outside the work zones.

Barriers

In addition to the site control measures identified above, barrier fencing or other appropriate barrier shall be placed and secured in such a manner as to prevent the public from entering active work portions of the site. Active work portions are considered any and all places where the public could be exposed to hazards of a physical, chemical, biological, and or general safety hazards.

10.2 Personal Hygiene and Decontamination

10.2.1 General

Decontamination shall mean the cleaning of all soil and other potentially hazardous substances from personnel, equipment or materials used or taken from the Site of Work. For this project, decontamination will include removing dust, debris, and soil potentially containing chemicals of concern from personnel, equipment, and vehicles leaving active exclusion zones, as well as prior to exiting the Site.

Temporary sanitary facilities will be established or identified at the site for the duration of the work and will be serviced at regular intervals. Workers will complete the following personal hygiene procedures before leaving the work site:

- Toilet and hand washing facilities will be located on site or an alternate sanitary facility and their specific location identified prior to beginning work activities.
- Where employees are engaging in the application of paints, coatings, or in other operations involving substances which may be harmful to the employees, cleansing facilities shall be provided in proximity of the worksite and shall be so equipped as to enable employees to remove such substances. Depending upon the problem, these facilities may be in the form of ordinary soap and

water or in the form of special compounds designed specifically for removal of the harmful material from skin surfaces.

- Potable drinking water will be on site for use by site personnel.

- Personal protective equipment shall be kept clean and in good repair. Safety devices, including protective clothing worn by the employee, shall not be interchanged among the employees until properly cleaned.

- All equipment leaving the site will be free of gross hazardous and non hazardous waste (i.e. mud and/or soil).

- AGSC shall:

    - Provide lunchroom facilities or eating areas for employees whose airborne exposure to lead is above the PEL, without regard to the use of respirators.
    - Assure that lunchroom facilities or eating areas are as free as practicable from lead contamination and are readily accessible to employees.
    - Assure that employees whose airborne exposure to lead is above the PEL, without regard to the use of a respirator, wash their hands and face prior to eating, drinking, smoking or applying cosmetics.
    - Assure that employees do not enter lunchroom facilities or eating areas with protective work clothing or equipment unless surface lead dust has been removed by vacuuming, or other cleaning method that limits dispersion of lead dust. <
    - Provide adequate hand washing facilities for use by employees exposed to lead.
    - Assure that employees wash their hands and face at the end of the work-shift.

Level C Decontamination

In the event that Level C PPE is donned to protect against hazardous waste and/or materials, the sequence for personnel decontamination for Level C PPE field activities is described below. Personnel decontamination for Level D PPE activities will include the applicable procedures described below. Decontamination will occur at either a temporary job site decontamination pad or at a central decontamination pad. The SHO will determine specific methods as follows:

- If gross contamination is present, wash PPE in detergent or other appropriate solution and rinse in clean water.

- Remove hard hat.

- Remove disposable over-boots (if used).

- Remove outer gloves.

- Wash chemical-resistant boots with detergent solution and rinse with clean water.

- Remove coveralls or Tyvek suit. Starting at the neck, roll the coveralls off from the inside out and down past the boots. Take care to prevent the release and dispersion of dusts or prevent contact with decontamination water that may have accumulated on the coveralls. Do not contaminate clothing inside the coveralls during removal.

- Place disposable PPE in an appropriate container for disposal.
- Remove the respirator. Dispose of cartridges in PPE disposal container. Clean and disinfect the respirators and place into a plastic bag for storage.
- Remove liner gloves.
- Thoroughly wash hands and face.
- Showers are not anticipated for this scope of work. Soap and water for hand and face cleansing will be available in the contaminant reduction zone.

All disposable protective clothing shall be removed during decontamination and shall be disposed of in a lidded container lined with a labeled drum liner. All waste generated at the site shall be disposed of according to the hazard classification of the debris.

- Wash hands with hand sanitizer stored on-site.

10.2.2 EQUIPMENT DECONTAMINATION

Respirators
Respirators if donned to protect against hazardous substances and other non-disposable PPE will be cleaned with alcohol wipes or manufacturer's supplied cleaning agents. AGSC will provide the cleaning agents for all equipment decontamination. When dry, respirators will be stored in accordance with Section 7.9. Cartridges cannot be cleaned. New cartridges will be installed at the start of each shift.

Equipment
In the event that equipment and materials (e.g. vehicles, temporary fencing, and dust control fabric) comes in contact with potentially contaminated soil, water, or air containing dusts or other aerosols, the equipment will be cleaned before and after each use on this project. Decontamination will consist of combinations brushing, steam cleaning and/or detergent (Liquinox® or equivalent) wash, tap water rinse, and distilled water rinse.

Tracks and tires of heavy equipment shall be brushed and scraped to remove contamination before leaving the site.

All waste from the decontamination process will be off-hauled with the rest of the waste to the disposal facility. The project manager and SHO will develop on-site a plan off-site disposal of decontamination wastes generated during these decontamination activities. At each work location the project manager will identify a location (with approval by the client) for the decontamination of personnel, vehicles, and equipment.

The following general safety rules will be strictly followed on site:

- Personnel will be briefed on the DHSP prior to site activities.
- Regular safety briefings will be conducted and recorded in the field logbook.
- Always employ the buddy system.

- Practice contamination avoidance.
- Plan activities ahead of time.
- Obtain immediate first aid for any and all cuts, scratches, abrasions, etc.
- Report all accidents, no matter how minor, to the SS or SHO.
- Be alert to your own physical conditions.
- Watch your body for signs of fatigue, exposure, or heat or cold stress.
- Work only in well-lighted areas.
- All personnel must immediately report any condition, practice, or circumstance they believe is unsafe.
- Also, see attached Cal OSHA Code of Safe Practices (to be posted on site).

11 Emergency Plan

As a result of the hazards on site and the conditions under which the operations are conducted, the possibility of an emergency situation (i.e. personal injury, fire or release of toxic substances) exists. An emergency plan will be updated as necessary. A copy of this plan will be posted at each work site by the SHO. Emergency equipment to be maintained on-site includes:

- 2 physician approved first aid kits.
- 3, 20-pound ABC fire extinguishers.
- 2 emergency eye wash units
- Two-way radios
- Spill Kits.

Additionally, a copy of the OSHA Job Safety and Health Protection Employee Information poster and the industrial insurance poster will be posted at the site.

11.1 Injuries

Injuries that occur at the job sites must be handled quickly and competently. When serious injuries, breathing difficulties, intense pain, or unconsciousness occur, other field personnel will immediately inform the SHO and call for help. An eyewash station that meets American National Standards Institute (ANSI) Z358.1 1990 standards will be available at the job site to treat minor eye injuries caused by splashing contaminants or particles. A first aid kit will be available at the job site to treat other minor injuries.

All injuries will be reported to the SS and SHO as soon as possible. An injury/illness report will be completed by the SHO and forwarded to the PM and COR within 24 hours of the incident.

11.2 On-Site Emergency Coordinator(s)

AGSC has assigned responsibility for the implementation of this emergency plan to the SS, Mr. Mike Collier.

Prior to the commencement of site activities, the SS will instruct all onsite personnel regarding the location of the emergency medical clinic. The SHO will inform the emergency clinic(s) about the nature and duration of work expected on the site, the location of the work sites and the type of contaminants and possible health or safety aspects of emergencies. Also at this time, AGSC and the emergency response units will make contingency plans to handle any emergencies that may occur.

The SHO will conduct an inspection of emergency response equipment on a weekly basis. This equipment will include fire extinguishers, first aid kits, and emergency eyewashes and spill control equipment. As part of the daily site walk-through, the SHO will pay close attention to potential fire hazards, spill potentials and individual work practices.

The SS will alter and/or amend this emergency plan whenever conditions at the site warrant such action. The SS will be responsible for ensuring the evacuation, emergency treatment and emergency transport of site personnel, as necessary. He will notify emergency response units, the Client and the appropriate staff as described below.

11.3 Emergency Phone Numbers and Hospital Address

11.3.1 Emergency Phone Numbers

Emergency	911
Fire	911
Sheriff	911
Ambulance	911
Chemtrec	(800) 424-9300
National Response Center	(800) 424-8802
Poison Control Center	(800) 876-4766
AGSC Safety & Health Officer (Mike Collier)	(530)-219-2597
ASGC PM (Randy Rogers)	(916) 802-2070
Acting Corporate CIH (Mr. Pete Rice)	(415) 518-8665
Hospital Phone:	**(805) 434-3500**
Hospital Address:	**Twin Cities Community Hospital** 1100 Las Tablas Rd Templeton, CA 93465

Directions to Hospital from Camp Roberts:

Take the US-101 South and go approximately 13.6 miles. Take the Las Tablas Road exit in the city of Templeton and go 0.1 mi. Turn Right on Las Tablas Road and go 0.3 mi. and arrive at 1100 Las Tablas Road, on the Right.

When using any driving directions or map, it's a good idea to do a reality check and make sure the road still exists, watch out for construction, and follow all traffic safety precautions. This is only to be used as an aid in planning.

11.4 Personal Injury

If the injury is minor, the victim will be escorted from the work area and receive first aid. In the event of serious personal injury (i.e., patient unconsciousness, possibility of broken bones, severe bleeding, burns, blood loss, shock or trauma), the SS or SHO will immediately:

- Call for assistance (local emergency number 911)
- Administer first aid, if qualified
- If not qualified, determine the extent of the injury and wait for assistance
- Notify the SS of the name of the individual involved, their location, and the nature of the injury
- Keep the patient warm and at rest.

- In the event of a chemical exposure provide a copy of the MSDS to the clinic

- Notify the PM
- Complete the Incident/Accident Report and the OSHA 300 log. An Incident/Accident Report will be submitted to the COR within 24 hours of the occurrence.

If the SS determines that emergency response is not necessary, he or she may direct someone to transport the patient by vehicle to the local clinic. The SHO will then complete the Incident/Accident report and the OSHA 300 log. In addition, the SHO will submit the ENG 3394 form to the USACE project manager.

11.5 First Aid Procedures to Personnel Exposure

If an over exposure to toxic materials should occur, the first responder to the victim will immediately perform the following per the procedures:

- Skin Contact: Wash/Rinse the affected area thoroughly with copious amount of soap and water, and then provide appropriate medical attention. If the skin and/or eyes are involved, they should be rinsed for at least 15 minutes.
- Inhalation: Move to fresh air; seek medical attention.
- Ingestion: Do not induce vomiting; seek medical attention.

AHTNA Government Services Corporation

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Appendix E: CSUMB Memo

MEMO TO: Greta Hilde / CSUMB
FROM: Richard Lampo / ERDC/CERL
DATE: July 21, 2004
SUBJECT: Detectable Lead In and/or On Recovered Wood

Background

For the last three years, the U.S. Army Engineer Research and Development Center, Construction Engineering Research Laboratory (ERDC/CERL), in partnership with other public and private organizations under various programs, has been conducting studies on the recovery of wood from excess military buildings that have been coated with lead-based paint. The primary focus of these investigations has been on methods to mechanically remove the lead-based paint film to make the processed wood available for reuse. Data from previous investigations by others indicated that lead could be detected within the board even after removing the paint film along with some underlying wood. In the process of the current work, analyses were conducted to further study this situation. Another issue that required further study was to determine if, and how much, lead could be detected in the dust on the surface of the boards after exiting the wood planing equipment. Data from these analyses are presented and discussed below.

Detectable Lead After Planing

Douglas fir siding was collected from two barracks at Fort Ord, CA, during the summer of 2002. Several random pieces were selected to assess the level of penetration of the lead compounds. Cuts to various depths, ranging from 0.04 to 0.10 in., were made using a standard woodworking planer. Analyses were conducted on a cross-section of the board at each successive depth of cut. With none of the paint film removed, the boards exhibited, on average, 5,500 mg/kg or ppm total Pb. At an average cut of 0.065 in., the average total lead was about 26 ppm – roughly 220 times lower than with the paint film included. At depths of cut 0.04 in. (the least amount that was removed) or greater, the total lead did not exceed 75 ppm. (None of the samples contained splits or knots where paint was still visible. The levels of lead would be locally higher at these locations. Complete removal of visible paint would be expected for all end products.)

Wipe Tests on Surface Dust

A mobile wood planer was used for a project at California State University at Monterey Bay (CSUMB) to mechanically remove LBP from building siding. Painted boards are fed in on one side of the unit and the “cleaned” boards exit on the other side. A series of wipe tests conforming to ASTM test method D1728 were performed to determine if, and how much, lead might be in the dust that remains on the surface upon exiting the machine. While not explicitly tested, the boards going into the MU would be expected to have an average total lead content on the order of 5,500 ppm since they are from the same location and vintage as the boards used to determine

values reported in the previous paragraph. The wipe sample results are reported in micrograms of lead/sf of surface area (μg/ft^2). The test results ranged from 100 to 1,500 μg/ft^2.

CSUMB also conducted wipe tests on recovered wood selected for further milling and use in the University's new Visitors' Center. While these boards were also run through the mobile wood planer, they were reportedly not previously painted (and taken from a different source than the siding represented in the wipe test results above). Rather, the boards were reportedly stained. It is unknown if any clear finish was present. As would be expected from these conditions, the results of these wipe tests were significantly lower (on average 20 μg/ft^2) than those from the siding where LBP was being removed.

Safe Handling and Use of the Processed Wood

Lead in the Recovered Wood

Currently there is no regulatory guidance explicitly focused at recovered wood previously coated with LBP where lead is still present in the wood within the detection limits of routine analytical methods. The amount of lead in consumer paints is regulated at a maximum 0.06% Pb, by weight (0.06% by weight equates to 600 ppm and, by definition, is considered to be "lead-free"). The purpose of this regulation is to protect against possible exposure by young children who are most susceptible to the harmful effects of the lead materials.

According to the Consumer Products Safety Commission (CPSC), a child can ingest around 15 micrograms (μg) of lead per day without inducing serious health problems. At a concentration of 25 ppm lead in the board (average level found after a depth of cut of 0.065 in.), a child would have to consume roughly 1.2 cubic centimeters (cm^3) of wood to yield 15 μg of Pb. At 75 ppm lead (a concentration greater than shown at any depth of cuts greater than 0.04 in.), that would equate to roughly 0.4 cm^3/day to be at the action level. Consumption by a child at quantities greater than these examples over an extended period of many days is not very likely.

Some of the Fort Ord siding planed and profiled into flooring at the Forest Products Laboratory (FPL) in Madison, WI, was installed in an office as a demonstration for the use of the recovered wood. After the floor was laid, it was sanded to provide a smooth, even surface. The person operating the sanding equipment was equipped with a personal air-monitoring device. No lead was detected in the airborne sampling. Roughly 0.06 in. of the siding was removed during the planing and profiling operations. (Further details on this and other procedures and tests performed as cooperative efforts between ERDC/CERL and FPL and referenced herein are contained in a draft ERDC/CERL report which will be published in late 2004.)

Lead in the Surface Dust

EPA guidance for clearance levels of lead in household dust (where children are present) is as follows:

- 40 µg/sf for floors
- 250 µg/sf for interior window sills
- 400 µg/sf for window wells

Under this guidance, the further handling and processing of the boards designated for the Visitors' Center would pose virtually no hazard for harmful exposures to Pb.

However, even the boards coming right out of the mobile planing unit are not considered to be a significant health threat to an adult using common sense practices in the handling and processing of these boards. For example, personal should wash their hands after handling or processing the boards and before eating, drinking, or smoking.

During the planing of siding at FPL, air monitoring was performed in the area around the equipment (the operations at FPL were performed indoors on a stationary wood planer equipped with a vacuum exhaust system) and for the personnel operating the equipment to determine if the planing operations on the LBP-coated siding might generate hazardous levels of airborne Pb. OSHA guidance in 29 CFR, Part 1926.62, for Permissible Exposure Limits (PEL) for airborne lead is 50 $\mu g/m^3$ averaged over an 8-hour work shift. The highest exposure at FPL was 4.6 $\mu g/m^3$ in an operation where the ends of the boards were cut-off to remove damaged or split ends before they were sent to the moulder.

Although the results would have to be confirmed by actual monitoring during the processing of the subject lumber, given the results of the FPL tests, the amount of lead in the dust or in the boards would not be expected to cause exposure conditions at action levels if normal industry and common-sense handling practices are employed.

Recommendations

The following information is provided as suggestions only. Neither ERDC/CERL nor I personally assume any liability relative to the accuracy of the data presented herein or the following suggestions. The University must make its own conclusions relative to the accuracy of the data and the validity of the suggestions.

- Continue as planned with the processing of the wood designated for use in the Visitor's Center. There is no apparent hazard for lead with the use of this wood.
- While the risks of health problems are considered to be low for the handling and further processing of the wood already run through the mobile planing equipment, lead is present at a level where it might be prudent to either require further cleanup of the dust (e.g., using a HEPA vacuum) or notification to the recipient of the possibility that lead containing dust may be present on the surface. A waiver could be signed by the recipient to assume all liabilities upon removal of the wood from the University property.

If there are any questions regarding the information presented in this Memo, please contact me at (217) 373-6765 or richard.g.lampo@erdc.usace.army.mil.

Appendix F: Airborne Asbestos and Lead Monitoring Data

Table F1. Ambient and personal air sampling results for asbestos fibers during asbestos abatement.

Sample ID	Collection Date	Sample Type	Activity Description	Results (fibers/cm3)
2212-1	3/16/2005	Personal	Asbestos mastic removal, 2nd floor, Building 2212	0.276
2212-2	3/16/2005	Ambient	Asbestos mastic removal, 2nd floor, Building 2212 Exit Clean Room east	0.002
2212-3	3/16/2005	Ambient	Asbestos mastic removal, 2nd floor, Building 2212, Negative air exhaust west	0.003
2212-4	3/16/2005	Ambient	Asbestos mastic removal, Building 2212, 2nd floor, dumpster east side	0.003
2212-5	3/16/2005	Personal	Asbestos mastic removal, 2nd floor, Building 2212	0.400
2212-6	3/16/2005	Ambient	Asbestos mastic removal, 2nd floor, Building 2212, exit clean room east	0.003
2212-7	3/16/2005	Ambient	Asbestos mastic removal, 2nd floor, Building 2212, negative air exhaust west	0.005
2212-8	3/16/2005	Ambient	Asbestos mastic removal, 2nd floor, Building 2212, dumpster east side	0.002
2212-9	3/16/2005	Personal	Asbestos mastic removal, 2nd floor Building 2212	0.010
2212-11	3/17/2005	Ambient	Mastic floor tile removal, 2nd floor, Building 2212 exit of clean room east	0.003
2212-12	3/17/2005	Ambient	Mastic floor tile removal, 2nd floor, Building 2212, exit of negative air west	0.002
2212-13	3/17/2005	Ambient	Mastic floor tile removal, 2nd floor, Building 2212, dumpster east side of debris bin	0.003
2212-14	3/17/2005	Personal	Mastic floor tile removal, Building 2212	0.009
2212-15	3/17/2005	Ambient	Mastic floor tile removal, 2nd floor, Building 2212, exit of clean room, east	0.004
2212-16	3/17/2005	Ambient	Mastic floor tile removal, 2nd floor, Building 2212, exit of negative air, west	0.002
2212-17	3/17/2005	Ambient	Matic floor tile removal, 2nd floor, Building 2212, dumpster south side	0.002
2212-18	3/17/2005	Personal	Mastic floor tile removal, Building 2212	0.049
2212-20	3/18/2005	Ambient	Mastic floor tile removal, 1st floor, Building 2212, exit of clean room east	0.002
2212-21	3/18/2005	Ambient	Mastic floor tile removal, 1st floor, Building 2212, exit of negative air, west	0.005
2212-22	3/18/2005	Ambient	Mastic floor tile removal, 1st floor, Building 2212, dumpster south side of debris bin	0.002

Sample ID	Collection Date	Sample Type	Activity Description	Results (fibers/cm3)
2212-23	3/18/2005	Personal	Mastic floor tile removal, Building 2212	0.009
2212-24	3/18/2005	Ambient	Mastic floor tile removal, 1st floor, Building 2212, exit of clean room, east	0.003
2212-25	3/18/2005	Ambient	Mastic floor tile removal, 1st floor, Building 2212, exit of negative air west side	0.002
2212-26	3/18/2005	Ambient	Mastic floor tile removal, 1st floor, Building 2212, dumpster south side of debris bin	0.002
2212-27	3/18/2005	Personal	Mastic floor tile removal, Building 2212	0.039
2213-29	3/21/2005	Ambient	Mastic floor tile removal, 2nd floor Building 2213, exit of clean room, east	0.002
2213-30	3/21/2005	Ambient	Mastic floor tile removal, 2nd floor, Building 2213, dumpster east side of debris bin	0.002
2213-31	3/21/2005	Ambient	Mastic floor tile removal, 2nd floor, Building 2213, exit of negative air west side	0.002
2213-32	3/21/2005	Personal	Mastic floor tile removal, Building 2213	0.403
2213-33	3/21/2005	Ambient	Mastic floor tile removal, 2nd floor, Building 2213, exit of clean room east	0.005
2213-34	3/21/2005	Ambient	Mastic floor tile removal, 2nd floor, dumpster east side of debris bin	0.007
2213-35	3/21/2005	Ambient	Mastic floor tile removal, 2nd floor, Building 2213, exit of clean room east	0.002
2213-36	3/21/2005	Personal	Mastic floor tile removal, Building 2213	0.187
2213-38	3/22/2005	Ambient	Mastic floor tile removal, 1st floor, Building 2213, exit of clean room east	0.002
2213-39	3/22/2005	Ambient	Mastic floor tile removal, 1st floor, Building 2213, east side of dumpster, south end	0.002
2213-40	3/22/2005	Ambient	Mastic floor tile removal, 1st floor, Building 2213, exit of negative air, west	0.002
2213-41	3/22/2005	Personal	Mastic floor tile removal, Building 2213	0.167
2213-42	3/22/2005	Ambient	Mastic floor tile removal, 1st floor, Building 2213, exit of clean room, east side	0.002
2213-43	3/22/2005	Ambient	Mastic floor tile removal, 1st floor, Building 2213, east side of dumpster, south end	0.002
2213-44	3/22/2005	Ambient	Mastic floor tile removal, 1st floor, Building 2213, exit of negative air, west side	0.002
2213-45	3/22/2005	Personal	Mastic floor tile removal, Building 2213	0.012

Sample ID	Collection Date	Sample Type	Activity Description	Results (fibers/cm3)
2213-46	3/22/2005	Ambient	Mastic floor tile removal, 1st floor, Building 2213, exit of clean room east	0.003
2213-47	3/22/2005	Ambient	Mastic floor tile removal, 1st floor, Building 2213, east side of dumpster, south end	0.003
2213-48	3/22/2005	Ambient	Mastic floor tile removal, 1st floor, Building 2213, exit of negative air, west	0.003
2213-49	3/22/2005	Personal	Mastic floor tile removal, Building 2213	0.014
2214-51	3/23/2005	Ambient	Asbestos abatement, Building 2214, exit of clean room east side	0.002
2214-52	3/23/2005	Ambient	Asbestos abatement, Building 2214, east side of dumpster, east side	0.003
2214-53	3/23/2005	Ambient	Asbestos abatement, Building 2214, exit of negative air exhaust, west side	0.002
2214-54	3/23/2005	Personal	Asbestos abatement, Building 2214	0.318
2214-55	3/23/2005	Ambient	Asbestos removal, Building 2214, exit of clean room, east side	ND (<0.002)
2214-56	3/23/2005	Ambient	Asbestos removal, Building 2214, east side of dumpster, east side	0.002
2214-57	3/23/2005	Ambient	Asbestos removal, Building 2214, exit of negative air exhaust, west side	ND (<0.002)
2214-58	3/23/2005	Personal	Asbestos removal, Building 2214	ND (<0.002)
2214-59	3/23/2005	Ambient	Asbestos removal, Building 2214, exit of clean room east side	0.016
2214-60	3/23/2005	Ambient	Asbestos removal, Building 2214, east side of dumpster, east side	0.021
2214-61	3/23/2005	Ambient	Asbestos removal, Building 2214, exit of negative air exhaust, west side	0.013
2214-62	3/23/2005	Personal	Asbestos abatement, Building 2214	0.009
2214-64	3/23/2005	Ambient	Asbestos abatement, Building 2214, exit of clean room, east side	0.002
2214-65	3/23/2005	Ambient	Asbestos abatement, Building 2214, dumpster, south end of building	<0.002
2214-66	3/23/2005	Ambient	Asbestos abatement, Building 2214, exit of negative air, west side	0.002
2214-67	3/23/2005	Personal	Asbestos abatement, Building 2214	0.099
2214-68	3/23/2005	Ambient	Asbestos abatement, Building 2214, exit of clean room, east side	0.002
2214-69	3/23/2005	Ambient	Asbestos abatement, Building 2214, east side of dumpster, south end	0.002
2214-70	3/23/2005	Ambient	Asbestos abatement, Building 2214 exit of negative air exhaust, west side	ND (<0.002)
2214-71	3/23/2005	Personal	Asbestos abatement, Building 2214	0.148

Sample ID	Collection Date	Sample Type	Activity Description	Results (fibers/cm3)
2214-72	3/24/2005	Ambient	Asbestos abatement, Building 2214, exit of clean room, east side	ND (<0.002)
2214-73	3/24/2005	Ambient	Asbestos abatement, Building 2214, east side of dumpster, south side	0.002
2214-74	3/24/2005	Ambient	Asbestos abatement, Building 2214, exit of negative air exhaust, west side	0.002
2214-75	3/24/2005	Personal	Asbestos abatement, Building 2214	ND (<0.002)
2213-77	3/25/2005	Personal	Asbestos abatement, Buildings 2213 and 2214, boiler room	0.107
2212-78	3/25/2005	Personal	Asbestos abatement, Building 2212, boiler room	0.102

Method: NIOSH 7400
ND = not detected

Table F2. Ambient and personal air sampling results for lead during deconstruction.

Sample ID	Collection Date	Type	Description	Results (ug/m^3)
2213-5LA	3/18/2005	Ambient	West side of Building 2213, paint scraping and siding removal	ND (<8.3)
2213-6PL	3/18/2005	Personal	Westside of Building 2213, paint scraping and siding removal	ND (<13.9)
2213-7PL	3/18/2005	Personal	South end of Building 2213, paint scraping and siding removal	ND (<13.9)
2213-8LA	3/18/2005	Ambient	West side of Building 2213, paint scraping and siding removal	ND (<6.9)
2213-9LA	3/18/2005	Ambient	South end of Building 2213, paint scraping and siding removal	ND (<6.9)
2213-10LA	3/18/2005	Ambient	East end of Building 2213, paint scraping and siding removal	ND (<10.4)
2213-1LA	3/25/2005	Ambient	West side of Building 2213, paint scraping and siding removal	ND (<6.9)
2213-2LA	3/25/2005	Ambient	West side of Building 2213, paint scraping and siding removal	ND (<10.4)
2213-3LA	3/25/2005	Personal	Building 2213 paint scraping	ND (<8.9)
2213-5LA	3/28/2005	Ambient	West side of Building 2213, paint scraping and siding removal	ND (<8.3)
2213-6LA	3/28/2005	Ambient	West side of Building 2213, paint scraping and siding removal	ND (<6.9)
2213-7LA	3/28/2005	Ambient	South end of Building 2213, paint scraping and siding removal	ND (<6.9)
2213-8LA	3/28/2005	Ambient	West side of Building 2213, paint scraping and siding removal	ND (<6.9)

Sample ID	Collection Date	Type	Description	Results (ug/m^3)
2213-9LA	3/28/2005	Ambient	South end of Building 2213, paint scraping and siding removal	ND (<6.9)
2213-10LA	3/28/2005	Ambient	East end of Building 2213, paint scraping and siding removal	ND (<10.4)
2213-12L	3/29/2005	Ambient	East end of Building 2213, paint scraping and siding removal	ND (<6.9)
2213-13L	3/29/2005	Ambient	South end of Building 2213, paint scraping and siding removal	ND (<6.9)
2213-14L	3/29/2005	Ambient	North side of Building 2213, paint scraping and siding removal	ND (<6.9)
2213-15L	3/29/2005	Personal	Building 2213 paint scraping and siding removal	12.7
2213-16L	3/29/2005	Ambient	East side of Building 2213, paint scraping and siding removal	ND (<6.9)
2213-17L	3/29/2005	Personal	Building 2213 paint scraping and siding removal	ND (<11.1)
2213-18L	3/29/2005	Ambient	North side of Building 2213, paint scraping and siding removal	ND (<6.9)
2213-19L	3/29/2005	Ambient	East side of Building 2213, paint scraping and siding removal	ND (<6.9)
2213-20L	3/29/2005	Personal	Building 2213, paint scraping and siding removal	ND (<11.1)
2213-21L	3/29/2005	Ambient	South of Trailer/paint scraping and removal	ND (<6.9)
2213-23LA	3/30/2005	Ambient	North end of Building 2213, lead scraping	ND (<6.9)
2213-24P	3/30/2005	Personal	Building 2213, lead scraping	ND (<11.1)
2213-25LA	3/30/2005	Ambient	East side of Building 2213, lead scraping	ND
2213-26P	3/30/2005	Personal	Building 2213, lead scraping	ND (<11.1)
2213-27LA	3/30/2005	Ambient	East side of Building 2213, lead scraping	ND (<6.9)
2213-28LA	3/30/2005	Personal	Building 2213, lead scraping	33.1
2213-29LA	3/30/2005	Ambient	West side of Building 2213, paint scraping and siding removal	ND (<8.3)
2214-32LA	3/31/2005	Ambient	West side of Building 2214, scrape LBP	ND (<6.9)
2214-33P	3/31/2005	Personal	Building 2214, scrape LBP	ND (<11.1)
2214-34LA	3/31/2005	Ambient	North side of Building 2214, scrape LBP	ND (<6.9)
2214-35LA	3/31/2005	Ambient	West side of Building 2214, scrape LBP	ND (<6.9)
2214-36P	3/31/2005	Personal	Building 2214, scrape LBP	ND (<11.1)

Sample ID	Collection Date	Type	Description	Results (ug/m^3)
2214-37LA	3/31/2005	Ambient	North side of Building 2214, scrape LBP	ND (<6.9)
2214-38LA	3/31/2005	Ambient	East side of Building 2214, scrape LBP	ND (<6.9)
2214-39P	3/31/2005	Personal	Building 2214, scrape LBP	ND (<11.1)
2214-41L	4/1/2005	Ambient	East side of Building 2214, scrape LBP	ND (<8.3)
2214-42L	4/1/2005	Ambient	South side of Building 2214	ND (<8.3)
2214-43L	4/1/2005	Personal	Building 2214, scrape LBP	ND (<13.3)
2214-44L	4/1/2005	Ambient	East side of Building 2214, scrape LBP	ND (<8.3)
2214-45L	4/1/2005	Ambient	South side of Building 2214	ND (<8.3)
2214-46L	4/1/2005	Personal	Building 2214, scrape LBP	ND (<66.7)
2214-48LA	4/4/2005	Ambient	South side of Building 2214	ND (<6.9)
2212-59LA	4/4/2005	Ambient	West side of Building 2212	ND (<6.9)
2212-50LA	4/4/2005	Ambient	West side of Building 2212	ND (<6.9)
2212-51P	4/4/2005	Personal	Building 2212	ND (<6.9)
2212-53LA	4/5/2005	Ambient	East side of Building 2212	ND (<6.9)
2212-54P	4/5/2005	Personal	Building 2212	ND (<8.3)
2212-55P	4/5/2005	Ambient	Southeast side of Building 2212	ND (<6.9)
2212-56P	4/5/2005	Personal	Building 2212	ND (<2.7)
2214-58LA	4/6/2005	Ambient	West side of Building 2214	ND (<6.9)
2214-59P	4/6/2005	Personal	Building 2214	ND (<11.1)
2214-60LA	4/6/2005	Ambient	East side of Building 2214	ND (<10.4)
2214-61P	4/6/2005	Personal	Building 2214	ND (<16.7)
2213-63LA	4/7/2005	Ambient	Inside of Building 2213, east end	38.1
2213-64P	4/7/2005	Personal	Building 2213	ND (<8.3)
2213-65LA	4/7/2005	Ambient	East/West side of Building 2213	ND (<6.9)
2213-66P	4/7/2005	Personal	Building 2213	ND (<66.7)
2213-67LA	4/7/2005	Ambient	East side of Building 2213	ND (<13.9)
2213-71LA	4/11/2005	Ambient	West side of Building 2213 roof	ND (<6.9)
2213-72P	4/11/2005	Personal	Building 2213	ND (<11.1)
2212& 2213-73LA	4/11/2005	Ambient	Between buildings 2212 & 2213 east and west ends	ND (<6.9)
2213& 2214-74LA	4/11/2005	Ambient	Between buildings 2213 & 2214 east and west ends	ND (<6.9)
2212& 2213-75P	4/11/2005	Personal	Between buildings 2212 & 2213	ND (<8.3)

Method: NIOSH 7082
ND = not detected